

089  
hp

**680 / 681**  
**682 / 683**  
**STRIP CHART**  
**RECORDERS**  
(includes metrics)

**OPERATING AND SERVICE MANUAL**



HEWLETT  PACKARD  
GRAPHIC RECORDERS



hp  
680

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OPERATING AND SERVICE MANUAL

**MODEL 680 SERIES  
STRIP CHART RECORDERS**

**INCLUDES 681, 682 & 683  
(and metrics)**

Serial Prefix: 712

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433 NO. FAIR OAKS AVENUE, PASADENA, CALIFORNIA

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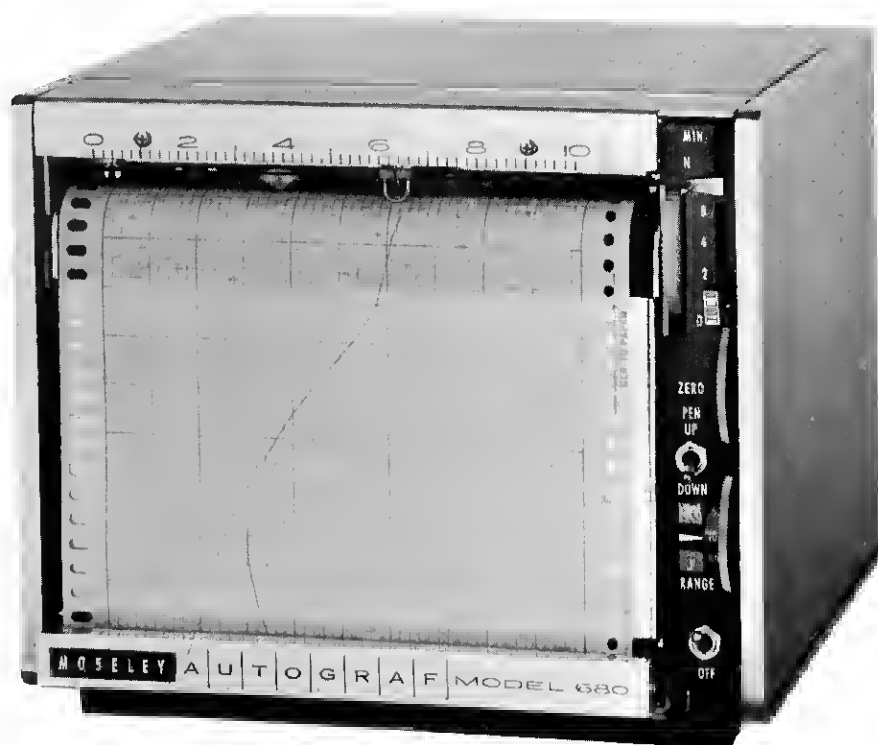


FIGURE 1-1. MODEL 680 STRIP CHART RECORDER

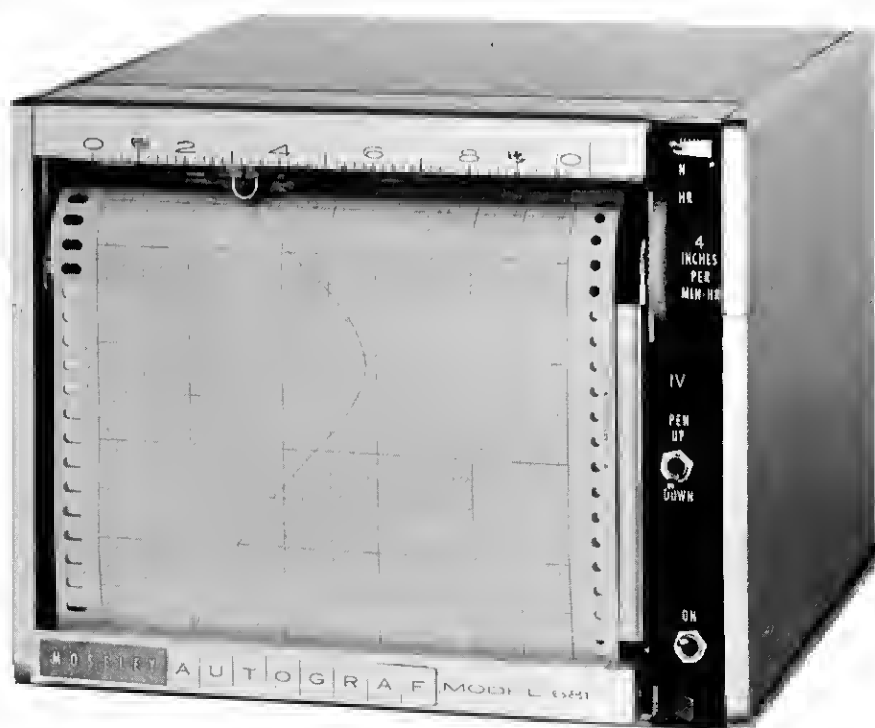


FIGURE 1-2. MODEL 681 STRIP CHART RECORDER



## SECTION I GENERAL INFORMATION

### 1-1. DESCRIPTION

1-2. **PURPOSE AND CAPABILITY.** The Moseley Model 680 Series Strip-Chart Recorders are general purpose laboratory and industrial instruments basically designed to plot cartesian coordinate graphs from DC electrical information in a rectilinear form on standard 6 inch by 100 foot chart paper with 5 inch writing width (12 cm). The physical construction of the instrument makes it readily adaptable to bench or rack mounting. Units are light weight and easily portable. All four models are available in metrically scaled and calibrated models. Available external accessories and options provide combinations to meet almost any requirement.

### 1-3. MANUAL IDENTIFICATION

1-4. This manual is applicable to the Model 680 Series. The models are identified by a Serial Prefix and Serial Number. The Serial Prefix is the first three digits of a two part, eight digit Serial Number (000-00000) used to identify each Hewlett-Packard instrument. If the Serial Number is higher than 712, a change sheet supplied with the manual will define the difference between that Model and the one described in this manual. Corrections to the manual, due to any errors that existed when it was printed, are called Errata, and appear only on the change sheet (if any) supplied with the manual. For information pertaining to manual coverage on any Hewlett-Packard instrument, contact the nearest Hewlett-Packard Sales/Service Office.

### 1-5. MODEL DIFFERENCES

1-6. This manual applies specifically to Model 680, 681, 682 and 683 Recorders. The following paragraphs describe features furnished under specific model designations:

**MODEL 680.** This is the most versatile recorder of the six inch strip-chart family and features 10 calibrated input spans, 8 chart speeds, continuous electronic reference, adjustable full scale zero set, and local or remote electric pen lift.

**MODEL 680M.** Same as the Model 680 except metrically scaled and calibrated.

**MODEL 681.** Similar to the Model 680 except for a single calibrated input span, and dual chart speed (in a 60 to 1 ratio).

**MODEL 681M.** Same as the Model 681 except metrically scaled and calibrated.

**MODEL 682.** This model is designed specifically for temperature recording. The recorder is supplied with one plug-in module and a customer selected single span compensated for the specified thermocouple type and reference temperature. Otherwise, it is identical to the Model 681.

**MODEL 682M.** Same as the Model 682 except for chart speed.

**MODEL 683.** This model was designed specifically as a current recorder. It has a single customer selected current span of up to a maximum full scale sensitivity of 5 micro-amperes. Other features and capabilities are the same as the Model 681.

**MODEL 683M.** Same as the Model 683 except metrically scaled and calibrated.

### 1-7. OPTIONAL FEATURES AND ACCESSORIES

1-8. The 680 Series Recorders offer many direct uses; however, the addition of accessories or exercise of options will provide a more specialized instrument for each particular application. They will also increase the utility of the recorder in a variety of functions. Metric accessories must be used on metric recorders for proper operation.

### 1-9. ACCESSORIES

1-10. **MODEL 7560A AND 7561A LOGARITHMIC CONVERTER.** Since the Model 7560A is designed to operate with a ten-inch recorder, the recorder must be factory modified to make both units compatible (see paragraph 1-21).

#### RECORDING MECHANISM:

INK: Servo actuated ink pen drive, free of ground, with local and remote pen lift and full scale zero adjustment.

ELECTROSENSITIVE: Similar to ink mechanism except a stylus for electrosensitive paper and the associated electronics are furnished in place of the ink pen.

#### CHART REQUIREMENTS:

INK: 6" by 100' roll charts, 5 inch (12 cm) writing width. Approximately 4" by 6" visible chart area during operation.

ELECTROSENSITIVE: 6" by 80' roll charts, 5" (12 cm) writing width.

RESPONSE TIME: One-half second or less for full scale.

#### CHART SPEEDS:

MODEL 680: Eight synchronous motor controlled speeds at 1, 2, 4, 8 inches per minute; 1, 2, 4, 8 inches per hour. Metric model: 2.5, 5, 10, 20 centimeters per minute; 2.5, 5, 10, 20 centimeters per hour.

MODEL 681, 682, 683: Two speeds in a 60 to 1 ratio as selected. Generally any speed up to 8 inches per minute (20 cm/minute on metric models) may be specified. Other speeds in a ratio of 16 to 1 may be supplied on all models.

#### SPANS:

MODEL 680: Ten calibrated spans of 5, 10, 50, 100, 500 millivolts; 1, 5, 10, 50, and 100 volts, full scale. Metric model has spans of 6, 12, 60, 120, and 600 millivolts; 1.2, 6, 12, 60, and 120 volts. An extra span of 1 millivolt, full scale, (1.2 millivolt on metric models) is available.

MODEL 681: Choice of a single full scale voltage span of essentially any value between 5 millivolts and 120 volts. Spans down to 1 millivolt may be ordered.

MODEL 682: Single selected temperature span. Thermocouple type and reference junction temperature must be specified when ordering.

MODEL 683: Choice of a single current span up to a maximum full scale sensitivity of 5 micro-amperes.

#### INPUT RESISTANCE:

MODEL 680, 681: 200,000 ohms per volt (166, 166 ohms/volt on metric models) full scale, through 10 volt span; 2 megohms on all others. Potentiometric input on most sensitive span permits operation with essentially zero current drain at null. Constant 100,000 ohm input resistance on all spans (except 1 millivolt and 1.2 millivolt models) available on both models.

MODEL 682: True potentiometric input drawing essentially zero current from signal at null.

MODEL 683: Input resistance dependent on current span selected. Standard model has basic sensitivity of 5 micro-amperes and 1000 ohms resistance, full scale (6 micro-amperes, metric model).

#### STANDARDIZATION:

Continuous electronic reference from zener diode controlled power supply. Calibration of Model 682 is in accordance with National Bureau of Standards circular 561 (1955), "STANDARD REFERENCE TABLES FOR THERMOCOUPLES".

#### ZERO SET:

MODEL 680: Continuously adjustable over full recorder span.

MODEL 681, 683: Adjustable by internal control. Unless otherwise specified, control will be factory set for zero-left operation.

#### ACCURACY:

Better than 0.2% of full scale with 0.1% of full scale resettability.

#### INTERFERENCE REJECTION:

DC common mode rejection better than 100,000 to 1 on 5 millivolt span.

#### POWER REQUIREMENTS:

115/230 volts, 60 cps, 22 volt-amperes. 50 cps models available at extra cost.

#### PHYSICAL DIMENSIONS:

6-3/32" high, 8" deep, 7-3/4" wide, approximately 10 pounds. Rack mounting requires 7 inches of vertical space.

FIGURE 1-3. SPECIFICATIONS

1-11. DUAL RACK ADAPTER, P/N A-15448. This accessory allows a 680 Recorder to be rack mounted in a standard 19" console. It will accept two 680 Recorders (side by side) or a 680 and any similar size H-P modular package, such as the F-3B.

NOTE: This rack adapter cannot be used with Option-14 (glass door).

1-12. DUAL RACK ADAPTER WITH GLASS FRONT, P/N M-18710. This accessory provides the same features as the preceding adapter, with the added feature of two individual locking glass doors. A single glass door mounted on the dual rack adapter and a removal blank panel is also available, P/N M-18709.

### 1-13. OPTIONS

1-14. RETRANSMITTING POTENTIOMETER (Option -01). 5K ohm potentiometer coupled to the recorder servo drive allows operation as a process controller, stable DC amplifier, or DC to AC converter with output of most any frequency or waveform desired (field installation).

1-15. EVENT MARKER (Option -02). Continuous recording Event Marker identifies significant points in the recording sequence by an inked trace at the right-hand margin of the graph paper. It is remotely actuated by a simple contact closure (factory installed).

1-16. LIMIT SWITCHES (Option -03). Adjustable over the full recording span, they provide a contact closure for remote control or indication of operational limits. Two switches may be installed, one for each margin (field installation).

1-17. 16 TO 1 SPEED REDUCER (Option -08). Replaces the normal 60 to 1 speed reduction ratio.

1-18. REMOTE CHART DRIVE SWITCH (Option -09). This switch allows the chart motor to be turned off by an external circuit in unattended operation. A variety of other uses is also possible.

1-19. 50 CPS OPERATION (Option -10). Special synchronous chart drive motor permits operation from 50 eps line source.

1-20. SPECIAL SCALE MARKINGS (Option -11). This option generally applies to a customer with a specific operation for the recorder, i. e., if measurement of light waves, tensile strength, etc. is to be made continuously, the scale can be marked in corresponding units of measure.

1-21. OPERATION WITH LOGARITHMIC CONVERTER (Option -13). A factory modification to the recorder to allow direct compatibility with the Logarithmic Converters, 7560A and 7561A.

1-22. LOCKING GLASS DOOR (Option -14). The door provides a means of preventing tampering with the recorder controls as well as offering a dust proof case. Recorder may be wall mounted or operated as a bench top instrument. Refer to figure 1-6 for illustration and installation of drawing (field installation).

1-23. ELECTRO SENSITIVE RECORDING (Option -15). Provides a crisp, clean, permanent record by means of an electrical stylus which replaces the ink pen. Special paper is required (factory installation).

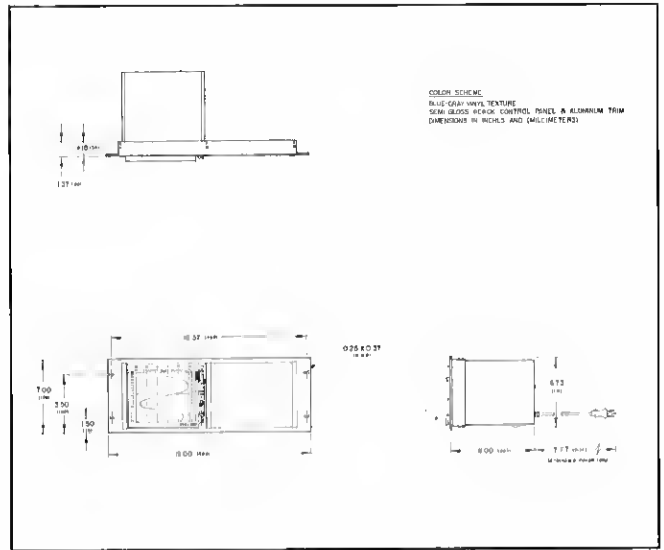


FIGURE 1-4. DUAL RACK ADAPTER A15448

1-24. ELECTRIC WRITING EVENT MARKER (Option -16). This event marker is used when electro sensitive paper is used. It can only be used in conjunction with option -15. Crisp, clean, permanent traces synonymous with option -15 are also provided by the event marker.

1-25. PHOTO-SLIDEWIRE (Option -17). This option replaces the standard wirewound mandrel and contacting wiper with a unique non-contacting balance potentiometer. The elimination of the contacting wiper eliminates cleaning and wear while increasing reliability and dependability. This option is not available on H01-680 and H01-680M.

1-26. DISPOSABLE PEN TIPS (Option -18). This option provides a pen using disposable pen tips. Both fiber pen tips (general and fast speeds) and molded capillary pen tips (slow speeds) are available. The clog resistant tip provides non-skip writing and eliminates critical pen alignment. Worn pen tips may be quickly replaced.

### 1-27. SPECIAL MODELS

1-28. ONE MILLIVOLT FULL SCALE SENSITIVITY. (1.2 mv f. s. on metric models.) For applications where unusually small input signal voltages must be recorded. Provides 0.5% full scale accuracy. Model numbers are prefixed by H01- on serial tag.

1-29. HIGH INPUT RESISTANCE. 100,000 ohms input resistance on all standard ranges; allows operation with minimum current drain from signal source. Model numbers are prefixed by H02- on serial tag.

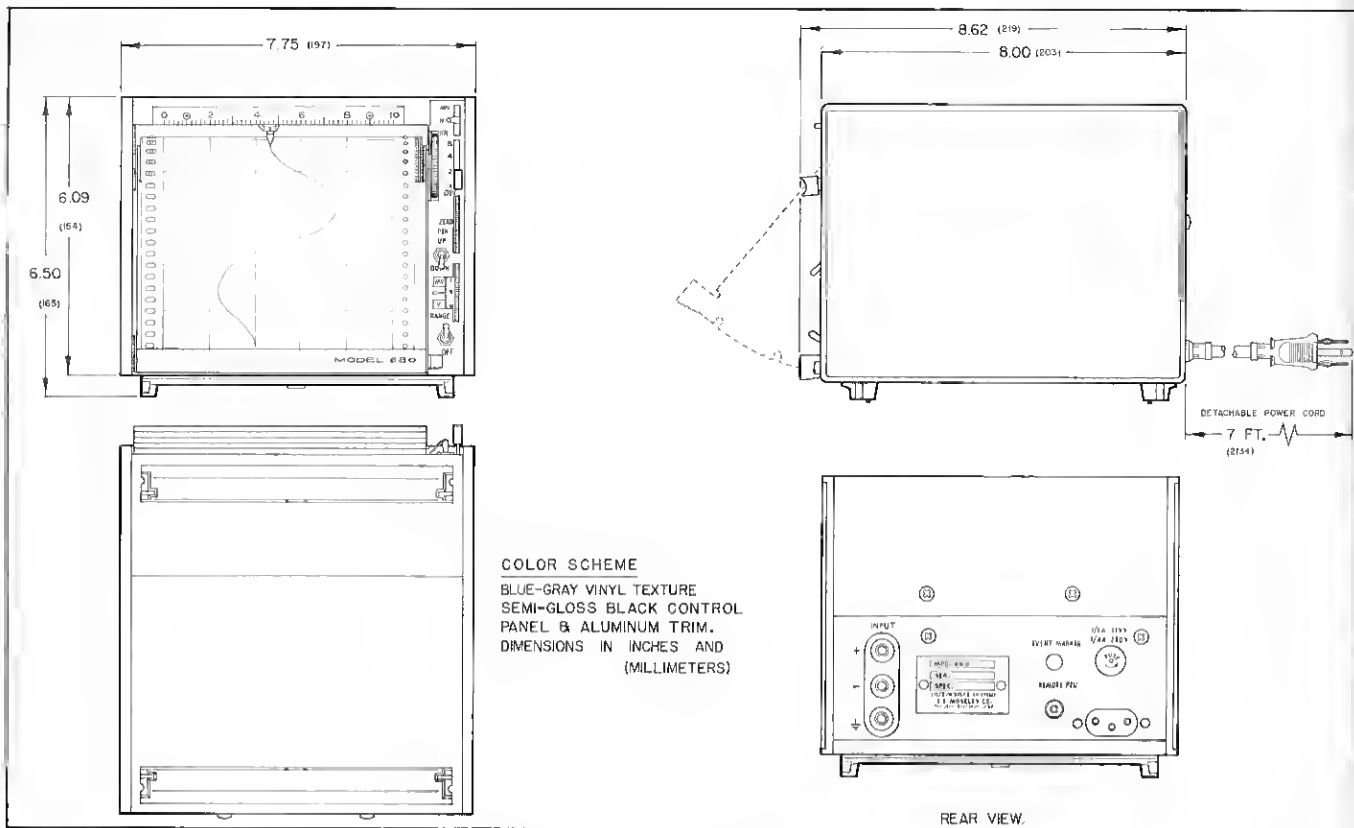


FIGURE 1-5. PHYSICAL DIMENSIONS

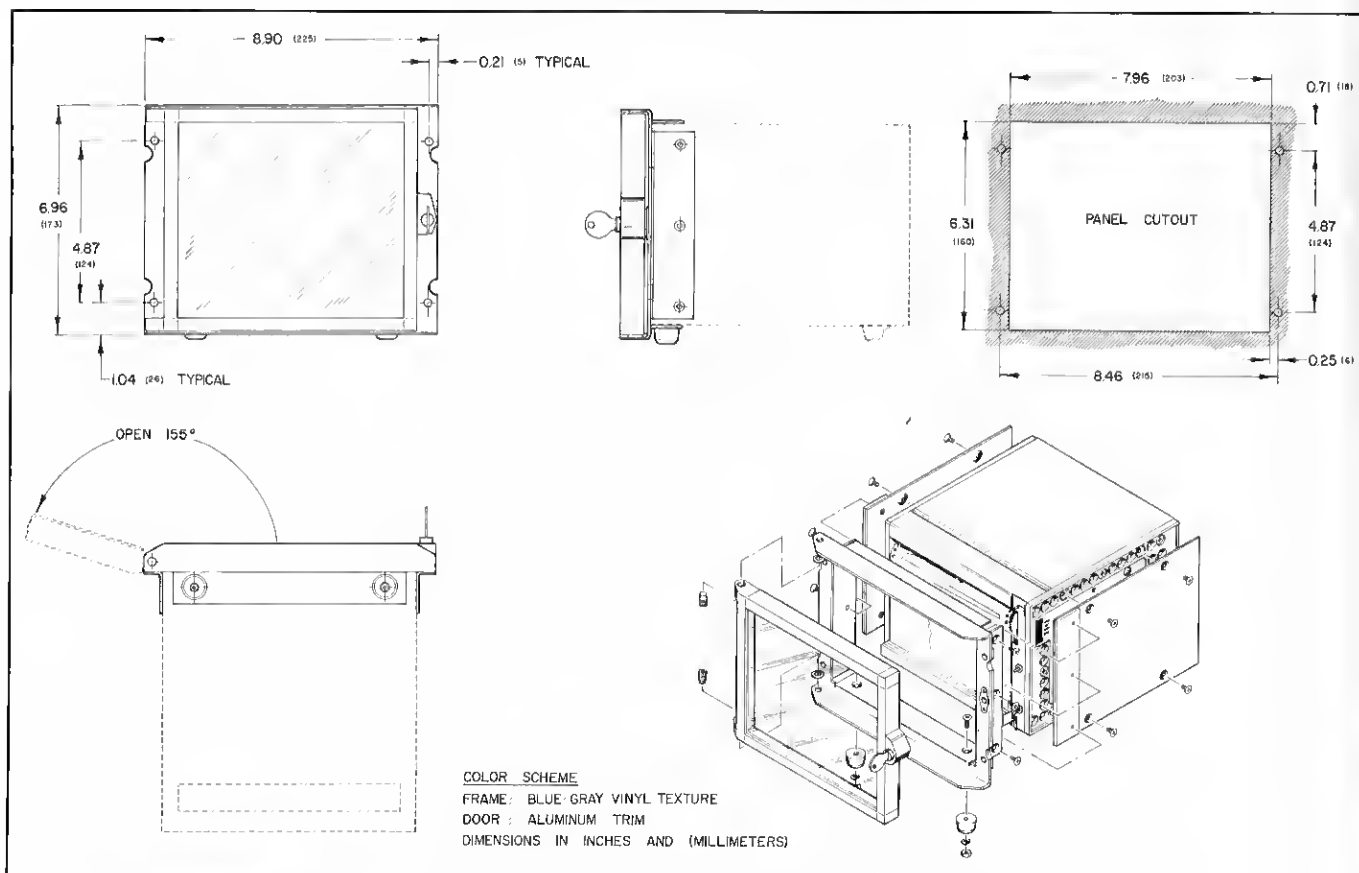


FIGURE 1-6. DIMENSION DRAWING OF DOOR ADAPTER (OPTION 14)

## SECTION II

### INSTALLATION AND INSPECTION

#### 2-1. INTRODUCTION

2-2. This section supplies information on incoming inspection, installation of recorder options, installation of recorders, storage, and shipping.

#### 2-3. INCOMING INSPECTION

2-4. MECHANICAL CHECK. If damage to the shipping carton is evident ask that the carrier's agent be

present when the instrument is unpacked. Inspect for mechanical damage, scratches, dents, broken knobs, etc. Also check for evidence of severe stress in the cushioning material.

2-5. PERFORMANCE TESTS. The electrical performance should be verified as soon as possible after receipt. Use performance inspection chart, figure 2-1.

#### REQUIRED INSTRUMENTS

- a. Stop watch
- b. DC Standard 1 volt - 50 mv - 50 volts
- c. Ohmmeter - 0-2 megohm range

1. Remove top cover and make sure 115/230 selector switch is correctly set at 115 volts. If 230 volts is the only available power source, set the selector to 230. Before applying power, check the fuse for proper value. A 1/4 ampere fuse is required for 115 volt operation and 1/8 ampere fuse for 230 volts.

2. Apply power to the recorder.

3. Check the remote pen and event marker plugs (if so equipped) for proper operation. This simply requires the closing of the two contacts.

4. CHART SPEED. A check of the chart speed varies with the model being inspected. On the Model 680 set the DIV control to the MIN position and set the gear train control to 1 div.

Run for 3 minutes at these settings using a stop watch for accurate timing. The line produced should be 3 divisions long. Set the DIV control to HR and the gear train control to 8 divisions. Run for 15 minutes, again using a stop watch. The line produced should be 2 divisions long. The same method is used on the other models in the series; however, they have only two speeds in a ratio of 60 to 1. Duration of time and length of line are dependent variables and must be calculated for the particular instrument tested.

NOTE: General operation procedures in Section III include installation of ink cartridges, chart paper, along with a complete listing of the functions of the control panel.

5. CALIBRATION. Similar to step 3 for chart speeds, calibration checks vary slightly with different models. The following checks are for the Model 680. Set the RANGE selector at 1 volt and position the pen at the zero mark. Apply a + 1 volt DC signal to the inputs for full scale deflection. Refer to Section I for specifications and tolerances.

FIGURE 2-1. PERFORMANCE INSPECTION CHART (Sheet 1 of 2)

A similar check should be made for the 50 mv and 50 volt ranges. Apply the required voltage for full scale deflection.

6. **LINEARITY** may be checked in a manner similar to that used in calibration except that a stepped input is employed. With the pen at "0" apply 10 steps of 0.1 volts each. (1.093 volts for

metric recorders in 12 steps.) Each step should line up with the major vertical divisions.

7. **INPUT RESISTANCE.** This may be checked at the input terminals with an ohm meter. A table of correct values is provided in Section III (figure 3-1).

FIGURE 2-1. PERFORMANCE INSPECTION CHART (Sheet 2 of 2)

2-6. **CLAIM FOR DAMAGE.** In case of mechanical damage or failure to meet specifications during performance tests, notify the carrier and nearest Hewlett-Packard field office immediately. Refer to listing in rear of this manual. Retain shipping carton and padding material for inspection by carrier. Arrangements will be made by the field office for repair or replacement of your instrument without waiting for settlement of a claim against the carrier.

## 2-7. STORAGE

2-8. If the instrument is to be stored for a period of time, the ink line should be flushed. The pen should be secured to the side of the instrument to prevent damage during handling. Seal the instrument in a moisture proof covering and repackage the unit in a container similar to the original factory one.

## 2-9. SHIPPING

2-10. Before returning instrument for any reason, notify the nearest field sales office of the difficulty encountered giving the model and serial number. They will provide shipping instructions. Prepare instrument for shipping in the manner outlined for storage, being careful to surround with at least three to four inches of shock-absorbing material to cushion and prevent movement inside container.

## 2-11. INSTALLATION

2-12. The 680 is a bench mounting recorder and require no physical installation. Rack mounting accessories are designed for installation in a standard 19 inch rack and require 7 inches of vertical space.

2-13. **COOLING.** Location or mounting should be chosen to insure sufficient circulation of air to cool by convection. No forced air cooling is provided.

## 2-14. INSTALLATION OF OPTIONS

2-15. **GENERAL.** All Model 680 Series recorders may be equipped with optional accessories which increase the versatility and application to special operating requirements. Many of these are described in paragraph 1-7. Some require factory installation while others are available in kit form. Sufficient information is presented in this section for customer installation of those available in kit form.

2-16. **OPTIONS AVAILABLE FOR FIELD INSTALLATION.** Kits may be secured for the installation of the following accessories:

- a. Retransmitting Potentiometer (A10953)
- b. Limit Switches (A10825)

**NOTE:** A mounting hole and adequate space are provided in the top rear of the recorder for acceptance of these accessories. See figure 2-2.

2-17. **INSTALLATION OF RETRANSMITTING POTENTIOMETER.** A three-turn 5K potentiometer may be connected to the drive shaft of the motor drive unit. The potentiometer is customer selected to provide the resistance range and linearity required by the particular application. To install:

- a. Remove top cover from the recorder to expose the motor drive unit.
- b. Place a flexible extension on the potentiometer shaft and insert the assembly from the rear of the recorder through the existing hole directly behind and in line with the drive shaft of the motor unit. While inserting, slip lock washer and nut over extension after it reaches opposite side of chassis.
- c. Guide end of extension to mate with motor drive shaft.
- d. Fasten the potentiometer to the recorder chassis with the mounting lock washer and nut.
- e. Adjust the potentiometer travel limits to agree with the recorder full scale travel limits.
- f. Tighten all set screws.

2-18. **INSTALLATION OF LIMIT SWITCHES.** The limit switch assembly supplied in kit form is installed in a manner identical to that used for the retransmitting potentiometer. (See paragraph 2-17.) After installation, operational adjustment should be made as follows:

- a. Loosen the locking set screws.
- b. Move the recorder zero control so that the pen is positioned at the desired high limit.

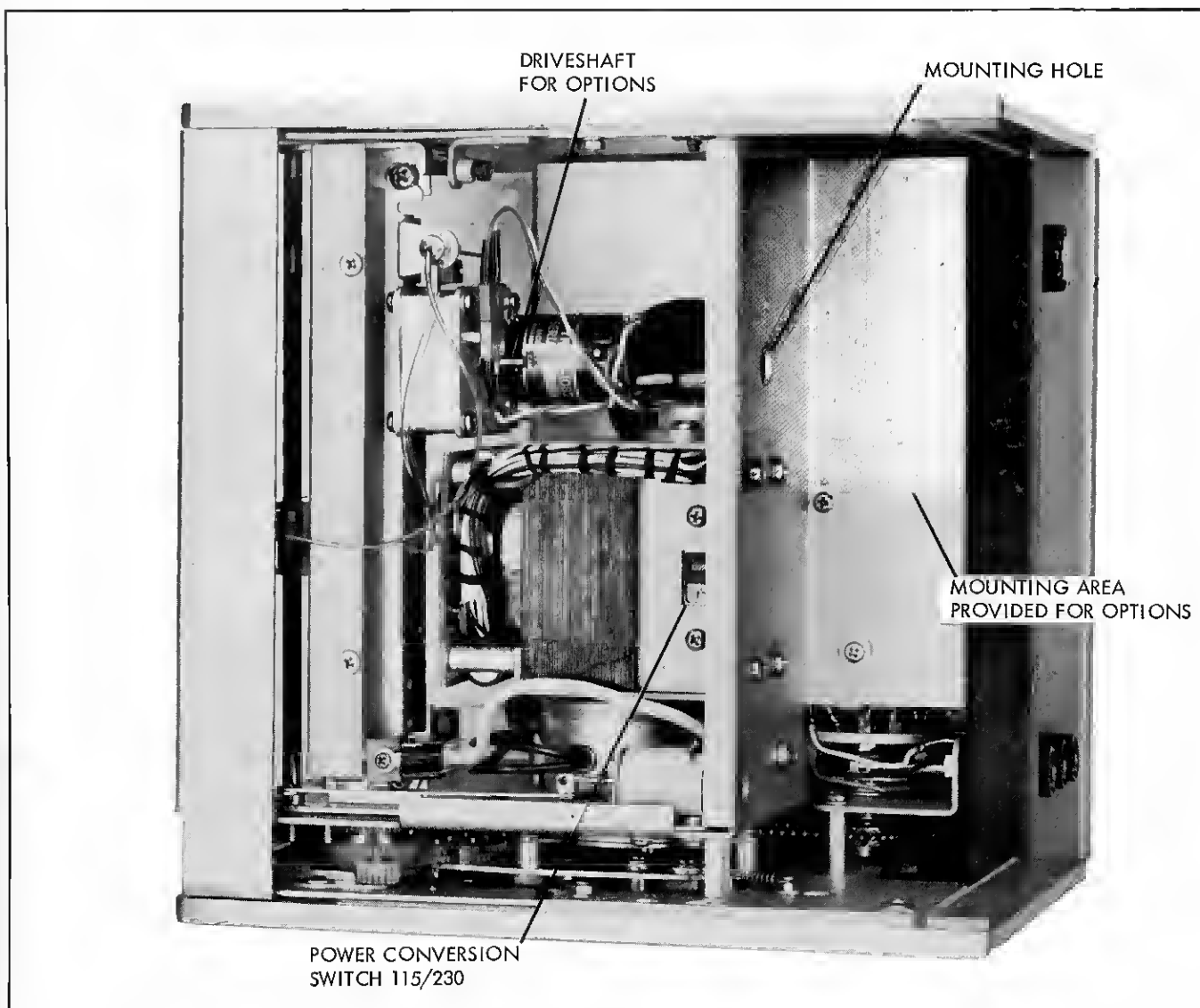


FIGURE 2-2. TOP VIEW OF RECORDER

c. Move the inner dial so that the high limit switch is closed. Tighten the set screw.

e. Move the outer dial so that the low limit switch is closed. Tighten the set screw.

d. Position the recorder pen for the low limit.

f. Verify the settings by operating the recorder and noting the resulting contact closures as the pen traverses the scale. Readjust, if necessary.

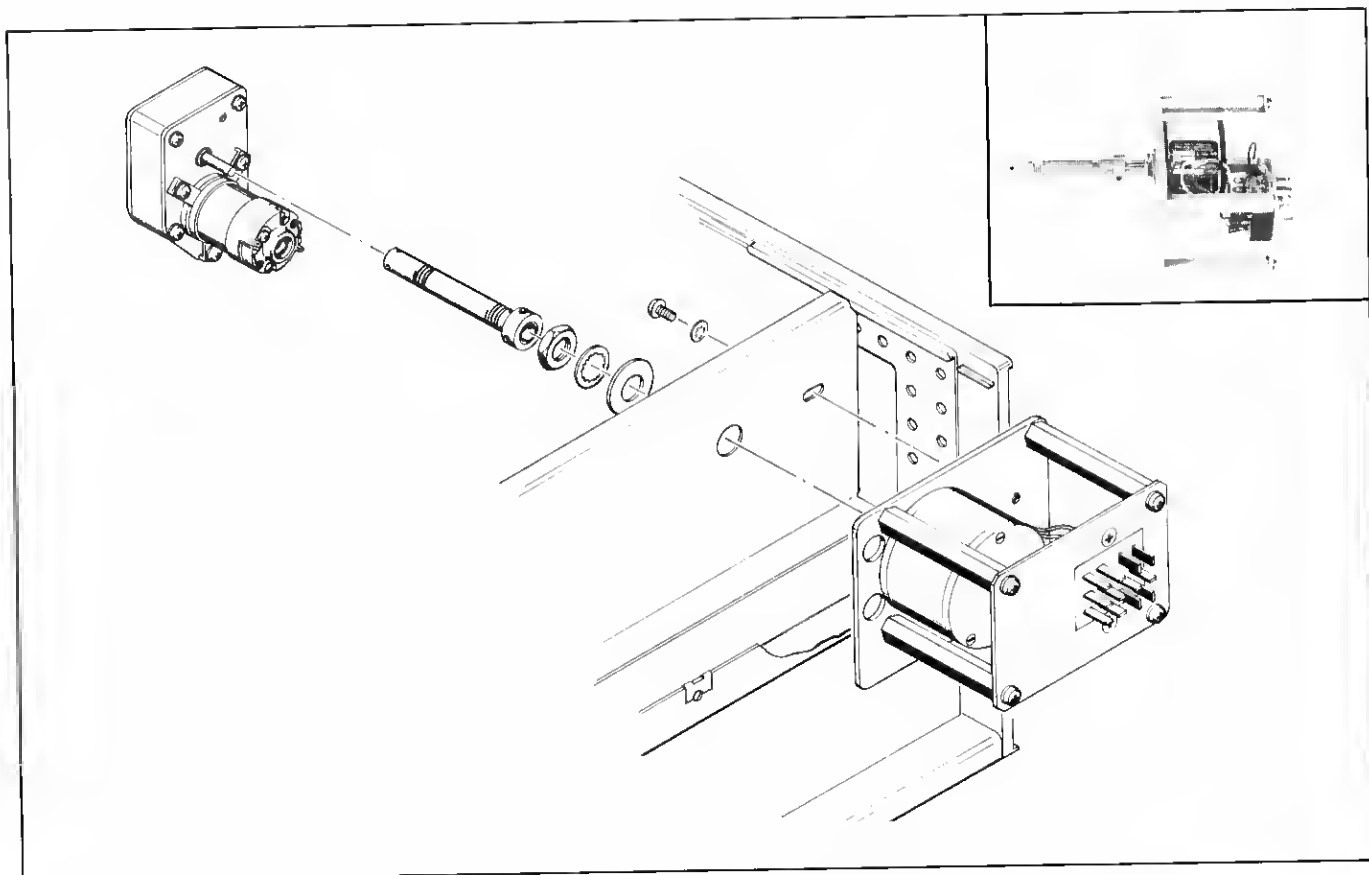


FIGURE 2-3. RETRANSMITTING POTENTIOMETER INSTALLATION

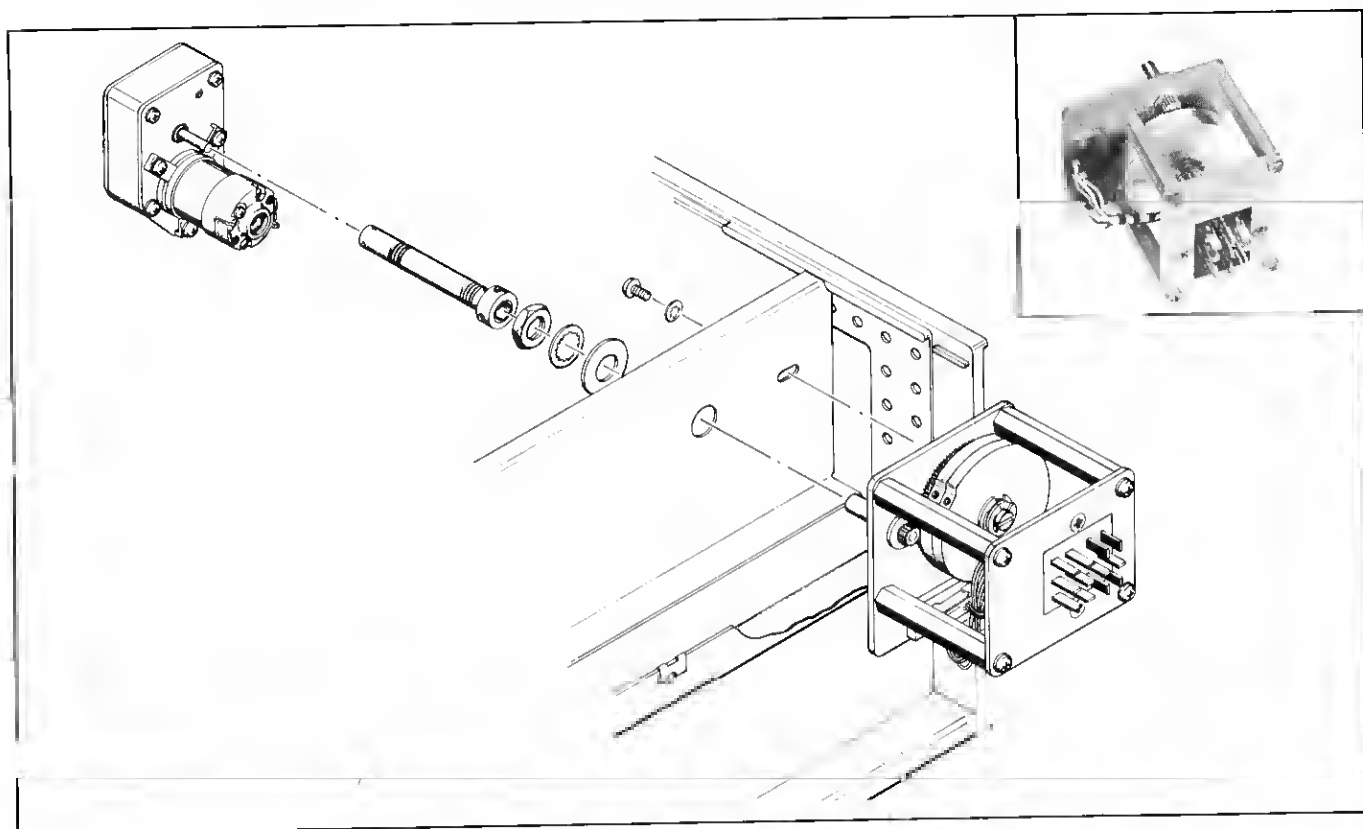


FIGURE 2-4. LIMIT SWITCH INSTALLATION



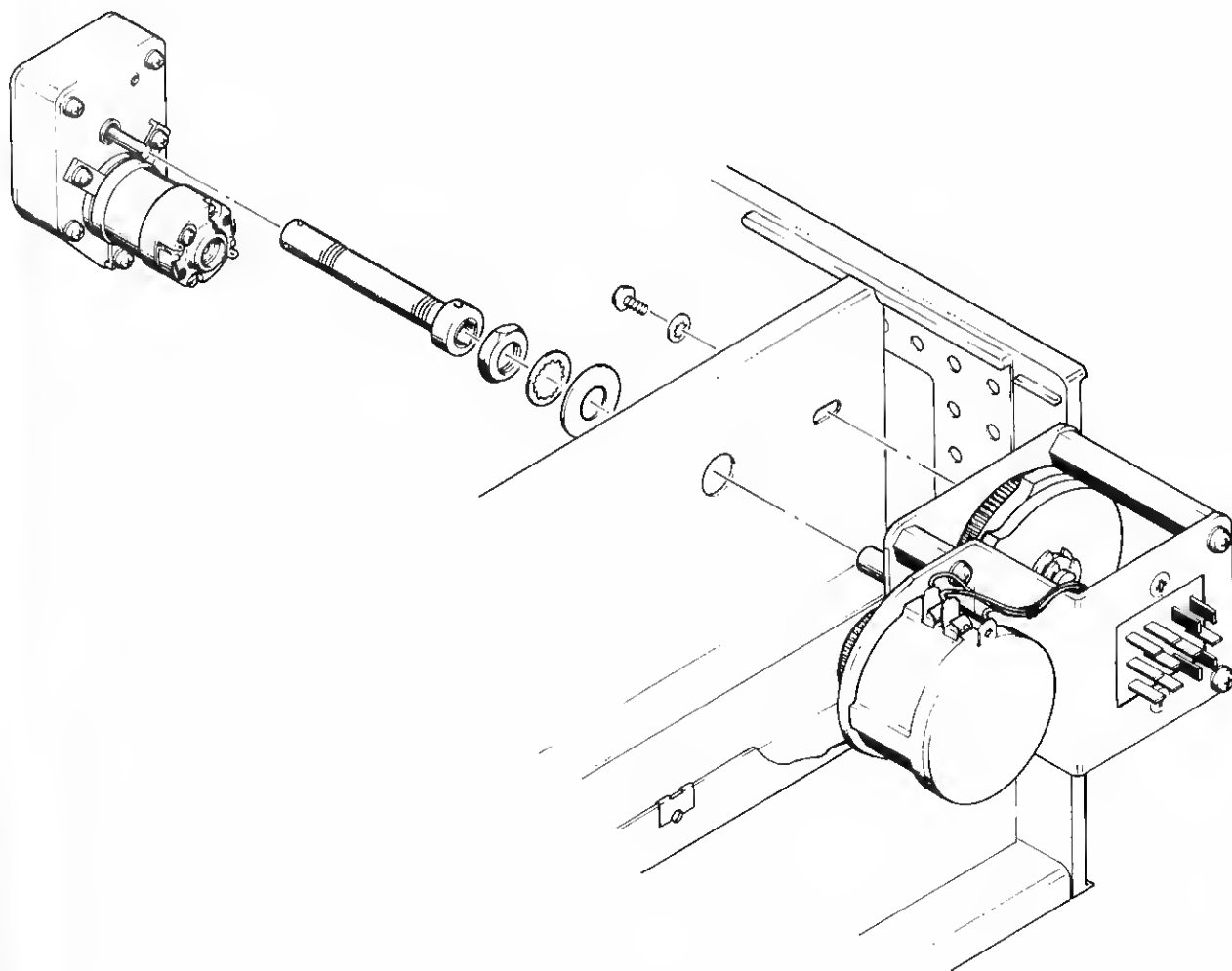


FIGURE 2-5. LIMIT SWITCH AND RETRANSMITTING  
POTENTIOMETER INSTALLATION

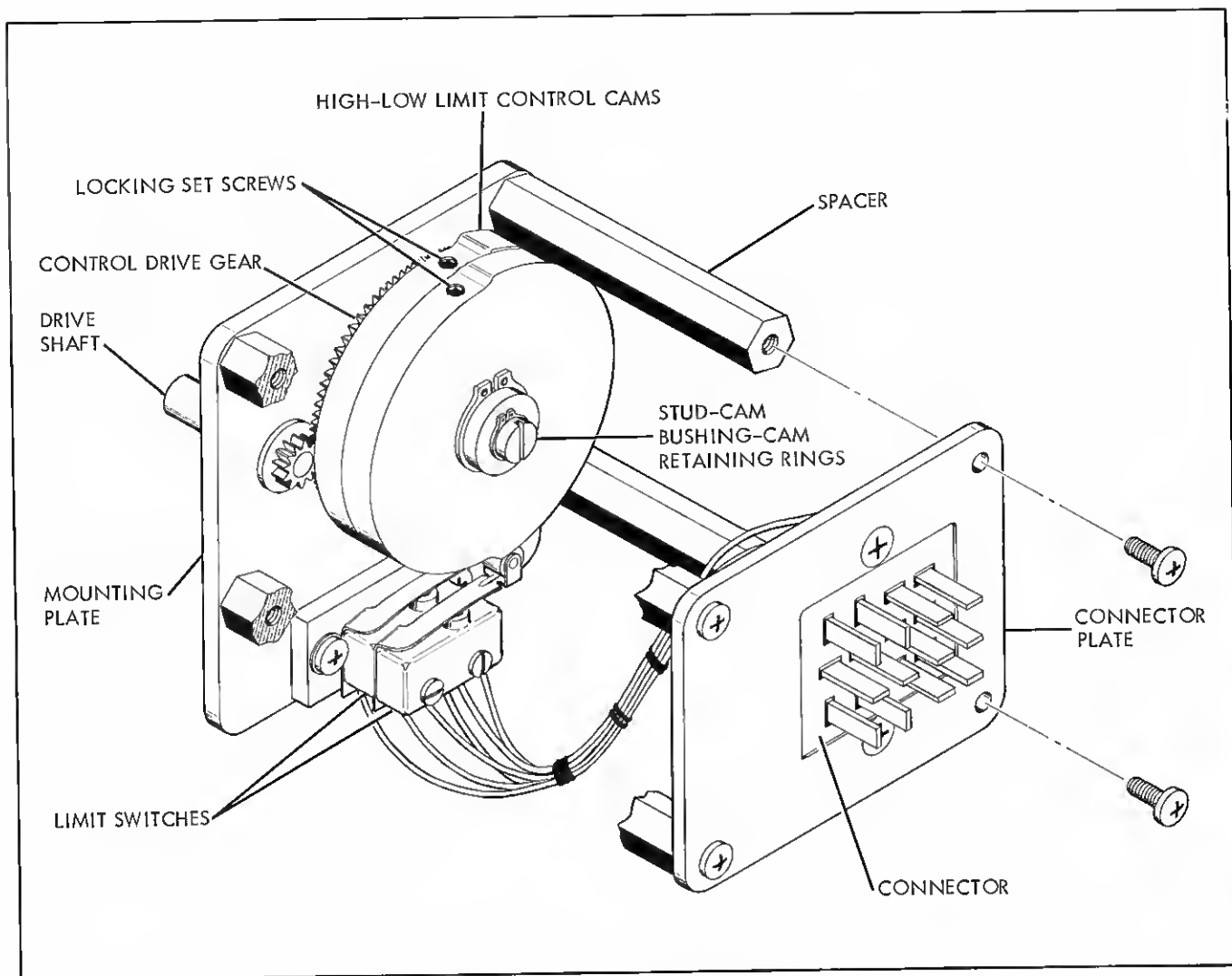


FIGURE 2-6. LIMIT SWITCH ASSEMBLY

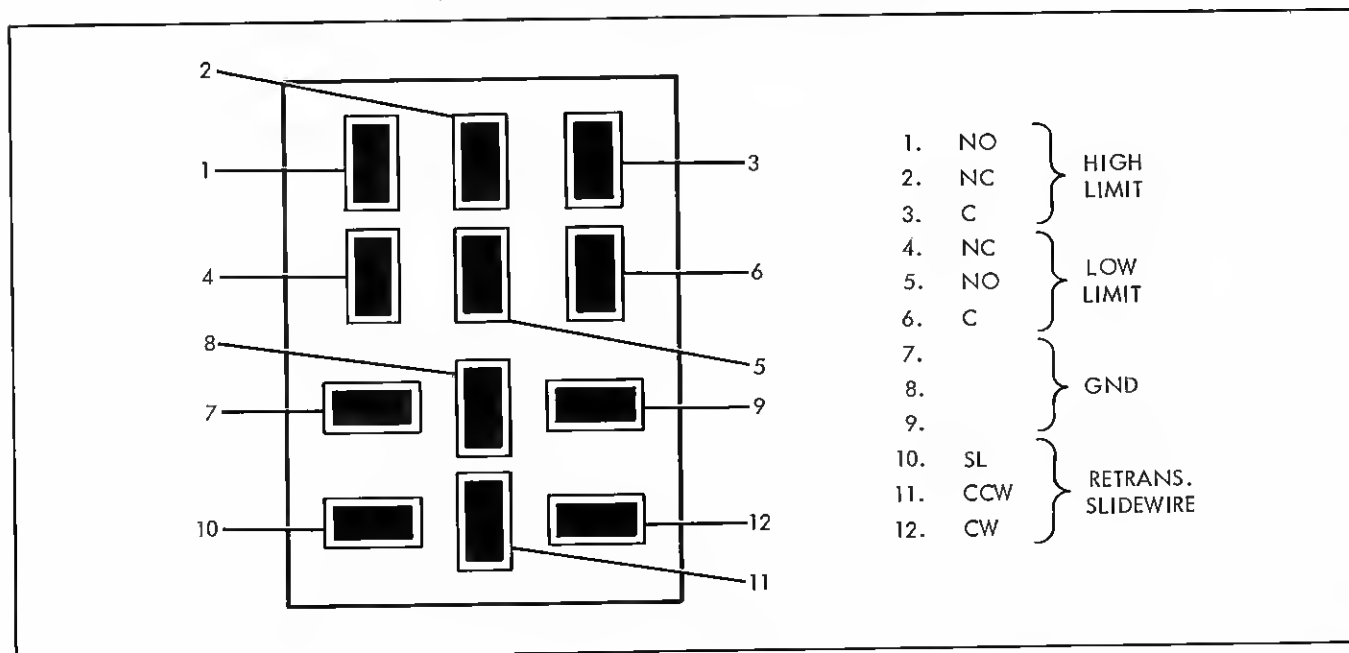


FIGURE 2-7. PIN ASSIGNMENT OF OPTIONAL EQUIPMENT CONNECTOR

## SECTION III

### OPERATING INSTRUCTIONS

#### 3-1. INTRODUCTION

3-2. The Model 680 series recorders are compact instruments designed to produce graphs showing the relationship between a variable function and time. An electrical signal representing the function is applied to the input terminals and the recorder controls adjusted so that the resulting graph will cover the desired scope of operation. The Model 680 is designed for general purpose recording, 681 for single range voltage recordings, 682 for temperature recordings, and the Model 683 for current recordings. Before operating, the user should become familiar with the input requirements and various control functions as outlined in the following paragraphs.

#### 3-3. ELECTRICAL REQUIREMENTS

3-4. OPERATING POWER. Standard recorders are designed for 115/230 volts, 60 cps operation. Fifty (50) cps operation is available on special models. A power conversion switch, located on the top of the instrument next to the transformer, (access requires removal of top cover) must be set to correspond to the available line voltage.

**CAUTION:** For optimum performance, the third prong of the AC power cord must be grounded. Grounding may also be accomplished by connecting the signal ground terminal to ground. Proper grounding has proven to be mandatory when operating from 230 volt power supplies, or from ungrounded power systems.

3-5. INPUT DATA SIGNALS. The recorder input terminals must be supplied with DC signals which are accurate functions of the original information. These signals must vary at a rate within the response capabilities of the instrument (1/2 second full scale), and have amplitudes within its scale ranges.

**CAUTION:** Do not exceed 120 volts inputs.

3-6. INPUT CONNECTIONS. The input terminals located on the rear of the instrument accept either open wires or banana type plugs. This type of terminal is standard on all models except the 682 which is equipped with a terminal strip.

#### 3-7. OPERATING CONTROLS (Refer to figure 3-2)

3-8. POWER SWITCH. The power switch controls instrument power. Its two positions are ON and OFF.

3-9. RANGE SELECTOR. (Model 680 only.) The scale positions are calibrated in volts or millivolts for full scale spans. The volts and millivolts spans are color coded with the coding clearly indicated next to the Range Selector.

**CAUTION:** Input potentials should never exceed 100 volts on the Model 680 and 120 volts on all other models (or full scale span).

3-10. PEN SWITCH. The pen switch controls the raising and lowering of the pen or stylus. In the UP position the pen is raised and in the DOWN position it is lowered. The raising and lowering of the optional event marker pen is also controlled by this switch.

3-11. ZERO CONTROL. A potentiometer permits placement of electrical zero anywhere on the graph. This control is adjusted externally on the Model 680. Models 681 and 683 have an internally adjusted potentiometer which is accessible by removing the bottom cover of the recorder. The screw adjustment is set for zero-left operation at the factory but may be readjusted with a common tip screwdriver. The Model 682 is not equipped with a zero control.

3-12. DIVISION CONTROL. (Model 680 only.) Designated "DIV". This lever allows selection of the chart speeds in divisions per minute or per hour,

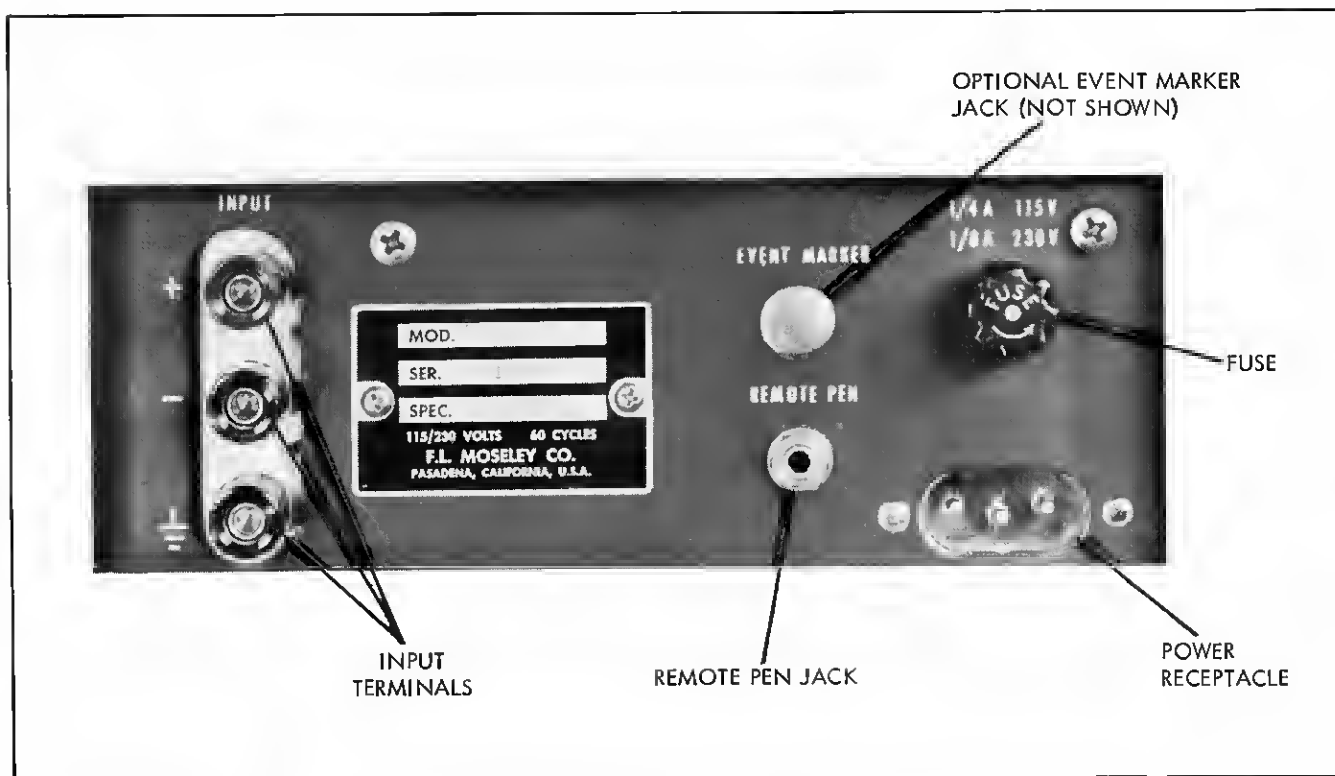


FIGURE 3-1. REAR PANEL

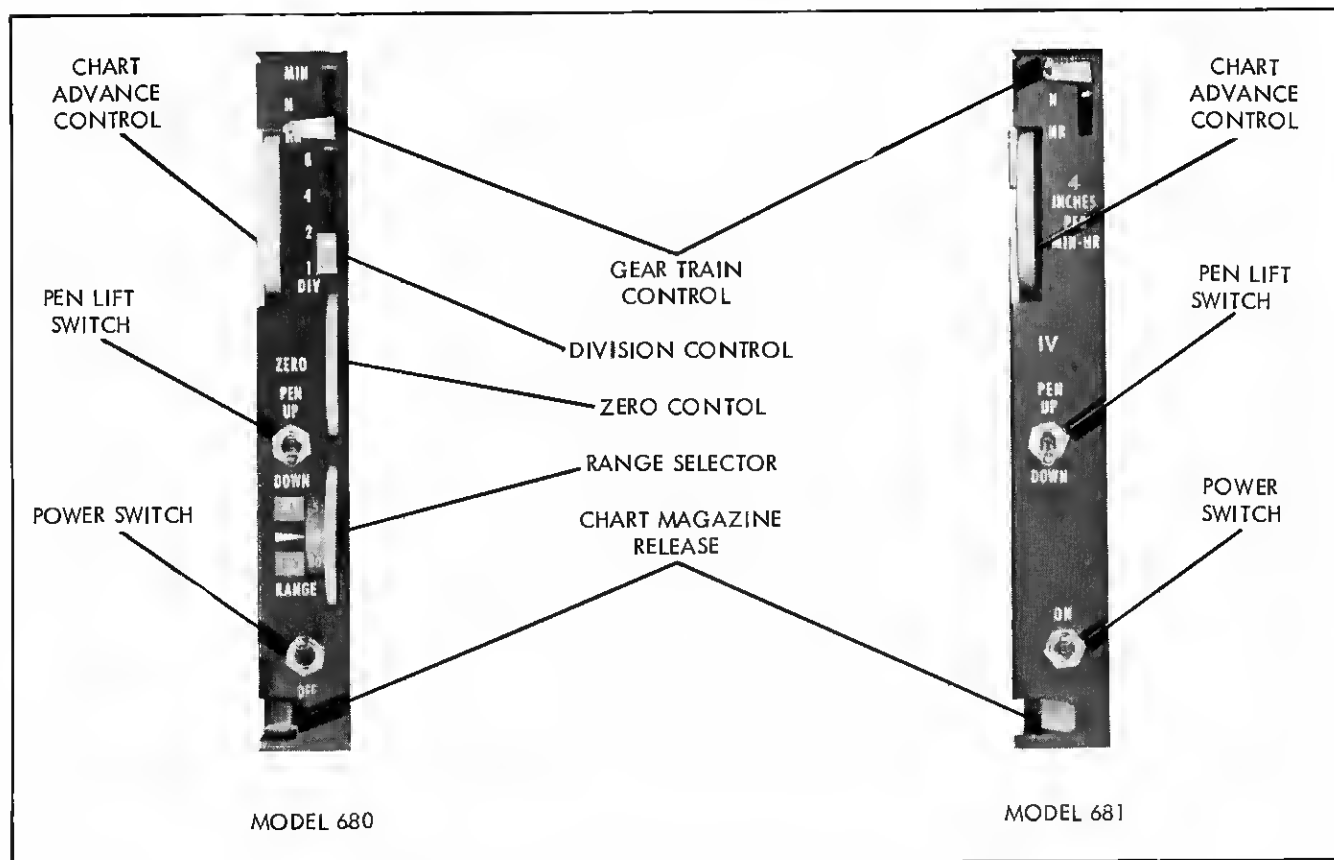


FIGURE 3-2. CONTROL PANELS OF MODEL 680 & 681

determined by the position of the gear train control. The four standard positions are 1, 2, 4, 8.

3-13. **GEAR TRAIN CONTROL.** This lever selects a 1:1 or 60:1 gear ratio. Thus when used on the Model 680 in conjunction with the Division Control in the MIN position (1:1 ratio) 1, 2, 4, and 8 are in inches or 2.5, 5, 10, and 20 centimeters per minute and when in the HR position (60:1 ratio) the divisions are in inches or centimeters per hour. All other models have this control but only one basic speed. A second speed is provided through the 60:1 ratio. The three positions of this lever are as follows:

1. "MIN" Chart will advance in inches or centimeters per minute. This is in a 1:1 ratio or direct drive coupling.
2. "N" Chart will stop. The neutral setting engages a clutch assembly which allows the chart drive motor to continue to rotate but disengages it from the chart drive.

3. "HR" Chart will advance in inches or centimeters per hour. This is in a 60:1 ratio drive.

3-14. **MANUAL CHART CONTROL.** With the gear train control set at "N" the manual chart control can be used to advance the chart manually.

3-15. **CHART LATCH.** Depression of the chart latch allows the magazine to be set in anyone of its three operating positions or to allow complete removal.

3-16. **REMOTE PEN CONTROL.** Remote pen control is available through a connector on the rear of the instrument. Connection of a contact closure across the connector terminals will cause the pen to lower. The raising and lowering of the optional event marker is by remote control.

3-17. **REMOTE CHART DRIVE CONTROL (OPTIONAL).** When furnished, remote chart drive control is obtained through a connector on the rear of

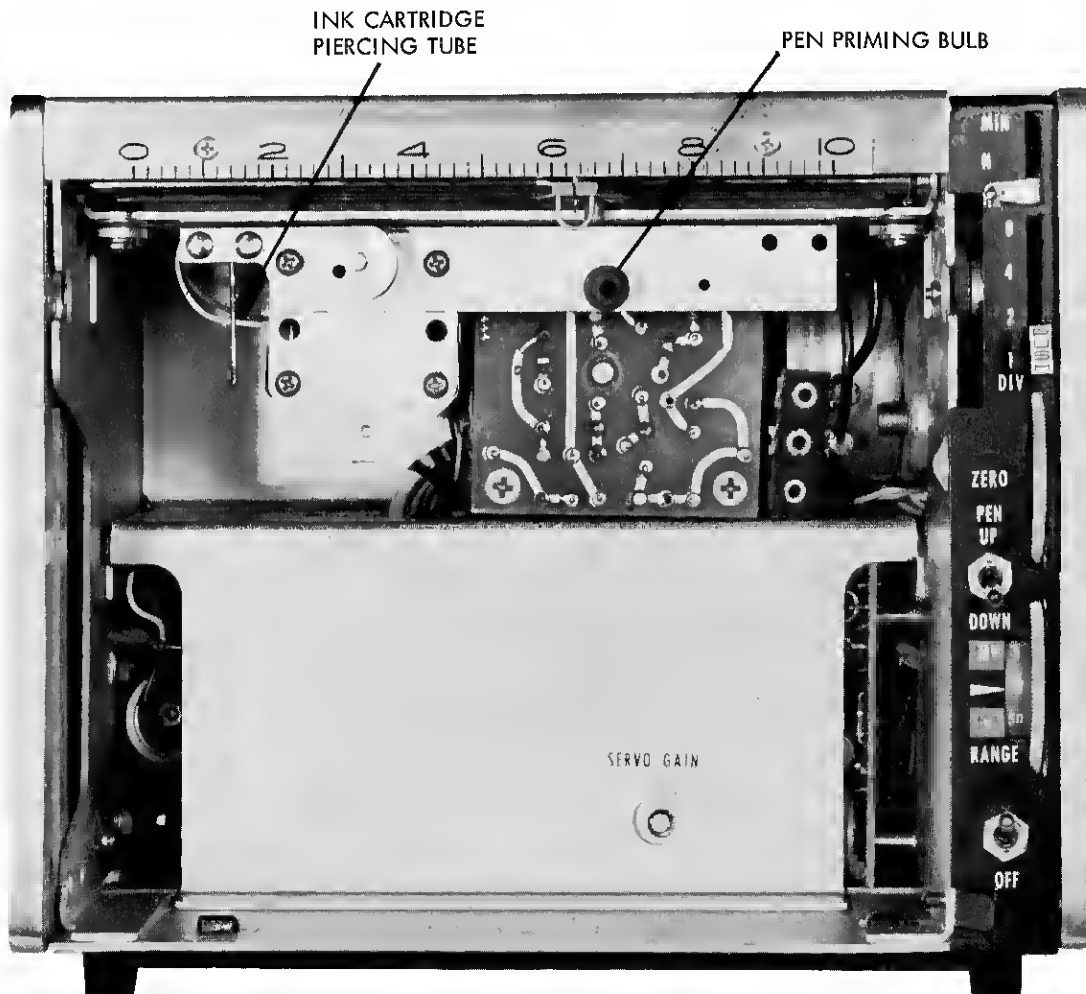


FIGURE 3-3. MODEL 680 WITH CHART MAGAZINE REMOVED

the instrument. A contact closure connected across the connector terminals will initiate the chart drive motor.

3-18. **EVENT MARKER (OPTIONAL).** When furnished, the connector for the event marker is mounted on the rear of the instrument. A contact closure connected across the connector terminals will initiate the event marks. Raising and lowering of the event marker pen or stylus is controlled by the main pen switch.

### 3-19. OPERATION PROCEDURE

3-20. **CONDITIONS OF OPERATION.** For satisfactory operation the applied input signal must be DC, the available voltage being an accurate function of the original information. Amplitudes of the signal must be within the scale ranges and vary in level at a rate within the response capabilities of the instrument (see paragraph 3-5).

| Span                     | Input Resistance (ohms/volt) | Full Scale Current Drain (micro-amperes) | Input Resistance (ohms) |
|--------------------------|------------------------------|--|-------------------------|
| 5 mv                     | 200,000                      | 5  | 1,000                   |
| 10 mv                    | 200,000                      | 5  | 2,000                   |
| 50 mv                    | 200,000                      | 5  | 10,000                  |
| 100 mv                   | 200,000                      | 5  | 20,000                  |
| 500 mv                   | 200,000                      | 5  | 100,000                 |
| 1 volts                  | 200,000                      | 5  | 200,000                 |
| 5 volts                  | 200,000                      | 5  | 1,000,000               |
| 10 volts                 | 200,000                      | 5  | 2,000,000               |
| 50 volts                 | 40,000                       | 25                                       | 2,000,000               |
| 100 volts                | 20,000                       | 50                                       | 2,000,000               |
| ENGLISH SCALED MODEL 680 |                              |  |                         |
| Span                     | Input Resistance (ohms/volt) | Full Scale Current Drain (micro-amperes) | Input Resistance (ohms) |
| 6 mv                     | 166,667                      | 6  | 1,000                   |
| 12 mv                    | 166,667                      | 6  | 2,000                   |
| 60 mv                    | 166,667                      | 6  | 10,000                  |
| 120 mv                   | 166,667                      | 6  | 20,000                  |
| 600 mv                   | 166,667                      | 6  | 100,000                 |
| 1.2 volts                | 166,667                      | 6  | 200,000                 |
| 6 volts                  | 166,667                      | 6  | 1,000,000               |
| 12 volts                 | 166,667                      | 6  | 2,000,000               |
| 60 volts                 | 33,333                       | 30                                       | 2,000,000               |
| 120 volts                | 16,667                       | 60                                       | 2,000,000               |
| METRIC SCALED MODEL 680  |                              |  |                         |

FIGURE 3-4. INPUT CHART

3-21. **OPERATION.** Provided the signal requirements are satisfied, the recorder may be placed into operation as follows:

a. Place the power switch ON.

b. Install ink cartridge. Depress the lever which is adjacent to the power switch at the bottom of the control panel, raise the chart magazine to a horizontal position and slide it from the recorder. Force the cartridge over the piercing tube of the corresponding pen and screw all the way on. The piercing tubes (up to two) are located in the same plane as the pen. See figure 3-3. Pen primers are located behind the chart magazine and just below the pen. Depressing the primer will force ink from the cartridge to the pen tip.

c. Load paper. Before replacing chart magazine install a roll of 6" width graph paper as follows: (Refer to figure 3-5)

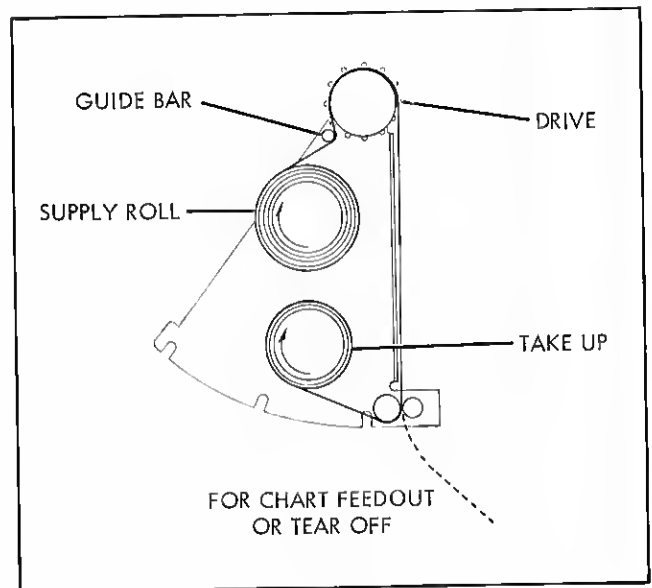


FIGURE 3-5. CHART LOADING DIAGRAM

(1) Position the empty chart magazine as indicated in figure 3-5.

(2) Insert the supply roll between the upper spring loaded hubs with the elongated drive holes of the paper to the right.

(3) Thread paper from the new supply roll under the guide bar.

(4) Bring the paper over the top of the sprocket drive drum and engage the sprockets.

(5) Pull the paper down across the face of the chart magazine and feed through the slot at the bottom of the platen.

(6) Rotate the drive gear so that the paper will feed through the slot.

(7) The paper will now feed out through the bottom of the chart magazine and may be torn off as the operator desires. If this type of operation is desired, the chart paper magazine may be installed in the recorder. For operation with the chart stored on a take-up spool within the chart magazine, continue with steps 8 and 9.

(8) Install an empty takeup spool (supplied) between the two lower hubs. Index the left end of the spool so the drive stud on the left hub mates with the slot on the takeup spool.

(9) Attach the end of the chart paper on the takeup spool with adhesive tape. Rotate the drive gear until several turns of paper are on the take-up spool. Inspect for proper chart tracking without buckling and then install the chart magazine.

d. When applicable, set the scale range to the expected maximum value. Connect the input signal to the input terminals.

e. The servo system should respond to the input signal. Adjust the range and zero controls on the models so equipped, to position the graph on the chart prior to actual recording.

f. Set the chart speed selector to the desired speed and actuate the drive motors.

g. Set the pen switch to DOWN.

### **3-22. OPERATING PRECAUTIONS**

3-23. Voltages in excess of the range setting (Model 680) or maximum scale voltage will drive the pen against the full scale stops. If this is allowed to continue, a slip clutch will permit the motor to run causing excessive clutch wear, motor overheating, and possible component failure.

## SECTION IV

### THEORY OF OPERATION

#### 4-1. GENERAL OPERATION DESCRIPTION

4-2. **SERVO MECHANISM.** The Models 680, 681, 682, and 683 strip chart recorders use a single isolated self-balancing servo-mechanism to move the pen, and a multi-speed motor drive to advance the chart. The pen moves at right angles to the direction of paper travel in response to applied input signals. The relative motion of pen and chart results in a plotted graph of function versus time.

4-3. **RANGE CONTROL** (Model 680 only). The basic voltage range of the servo system for the Model 680 is 5 millivolts full scale. Operation with greater voltages is obtained by switching precision resistors into the balancing circuit. In operation, the initial range setting is based on the expected maximum voltages. Included in the input circuit is a filter which minimizes undesirable noise and ripple disturbances in the input signals.

4-4. **BALANCING ACTION.** After passing through the attenuator, the input signal is applied to the balance circuit where it is cancelled by an internally supplied opposing voltage. Under these conditions, there is no signal output from the balance circuit and the servo system is at null. When the input signal changes value, an unbalanced condition exists. The error signal (voltage difference) is applied to a chopper which converts the DC to a 60 cycle AC form. This is amplified and applied to the control winding of a servo motor. Because the motor and rebalance potentiometer are mechanically coupled, the balance voltage changes value until the new input signal is cancelled. If the input data is constantly varying at rates within the capabilities of the instrument, this rebalancing action is continuous and the rebalance potentiometer and pen or stylus are always in a position directly proportional to the amplitude of the signal at the input terminal.

#### 4-5. CIRCUITRY DIFFERENCES BETWEEN MODELS

4-6. Although the Models 680, 681, 682, and 683 recorders are similar, the different functions performed by each require individual distinct circuit treatment. Each will be explained separately. Description of the 100K and 1MV Specials will also be found in this section.

#### MODEL 680, 680M -CIRCUIT DESCRIPTION

4-7. Circuit description and symbols apply to both instruments. Refer to schematic in section seven.

4-8. **INPUT CIRCUIT.** Input terminals mounted on the rear of the recorder are connected to a precision voltage divider which determines the maximum allowable input voltage. The input attenuator consists of four precision  $\pm 0.1\%$  wirewound resistors R-101 through R-109. These resistors are located in the lower rear portion of the chart drive and control section. With the range switch in the first position, the input voltage is applied across 1K ohms, R-111, and goes directly to the balance circuit with no attenuation. The voltage in the balance loop allows a signal up to 5 millivolts full scale to be applied to the balance circuit without prior attenuation when the range switch is set to the first range (5 millivolts). Input signals greater than this must be attenuated before reaching the balance circuit. To obtain higher voltage ranges, resistance is inserted in series with R-111 (1K) up to the 10 volt range. Beyond this range R-108 or R-109 is connected in parallel with R-111 thus decreasing the resistance applied at the 10 volt position.

4-9. **POTENTIOMETRIC INPUT.** This mode of operation provides maximum sensitivity with



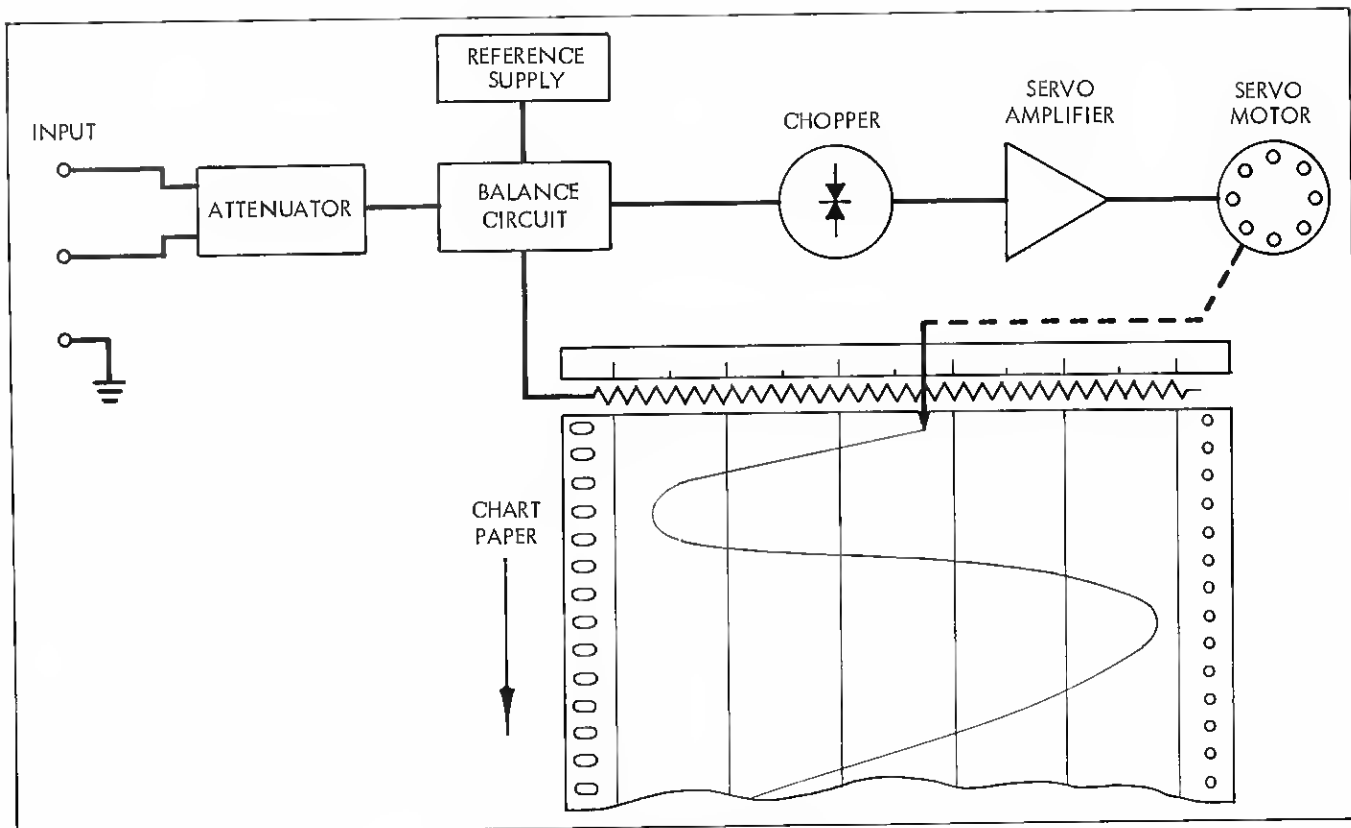


FIGURE 4-1. BLOCK DIAGRAM

minimum current drain from the signal source. Both models may be converted to this type of input. Full scale deflection is then obtained with 5 millivolts applied to the input. The range switch must be set at the 5 millivolt range. Five millivolts applied to the input will then drive the pen full scale. Source impedance must be no greater than 1500 ohms. Conversion to potentiometric operation is described in Section V, paragraph 5-22.

**4-10. INPUT FILTER.** The input signal is applied across a three section RC filter to minimize noise and ripple factors. The filter components are resistors R-110, R-122, R-123, and capacitors C-102, C-103, C-104. For component location see Section VII.

**4-11. REFERENCE SUPPLY.** The reference voltage is derived from a zener controlled DC power supply, nominally 6 volts, stable to 0.05% with line variation up to  $\pm 10\%$ . The primary of the transformer T-300 is supplied with either 115 or 230 Volts AC. A third secondary winding supplies the reference supply. Diodes CR-307 and CR-308 provide full wave rectification. The output is then filtered by an RC filter composed of R-303 and C-303. Two stages of zener regulation is provided by R-305, CR-310 and R-306, CR-311. Diode CR-310 has high regulating ability and is used to reduce the line voltage variation appearing in the rectified output. Diode CR-311 is a highly stable zener diode which further regulates the output of the previous stage for greater stability. This diode is operated at current and voltage levels which provide temperature compensation for the reference supply.

**4-12. BALANCE CIRCUIT.** After passing through the input attenuator, the DC input signal is applied to the balance circuit where it is opposed by a DC cancellation voltage from the internal reference supply. The difference between these two voltages (error signal) is applied to the servo amplifier which drives the servo motor. The rebalance potentiometer R-129, being mechanically coupled to the servo, is driven in a direction to produce a voltage which cancels the error signal produced by the input voltage. The calibrate potentiometer R-128 adjusts the calibrate voltage appearing across the rebalance potentiometer so that the servo balances at full scale with 5 millivolts. Resistance in the balance circuit is sufficiently high for the balance potentiometer to impose little current drain on the reference supply, but low in value compared to R-125. This holds the loading and linearity of the balance potentiometer within the accuracy limits of the instrument. DC attenuation by R-124 reduces noise at R-129 by better than 200 to 1. This noise is predominantly the result of two effects, imperfect contact of the slider on the resistance element (in R-129) during travel resulting in a saw tooth component of noise voltage, and a triboelectric DC voltage generated by friction of dissimilar metals. R-121 provides ZERO control. This potentiometer introduces into the balance circuit a controlled error signal which is cancelled in the same manner as a regular input error signal. This control provides a means for placing zero anywhere within the graph limits.

**4-13. CHOPPER AND INPUT TRANSFORMER.** The DC difference between the input signal and the



**4-19. CHART DRIVE SYSTEM.** A sixteen RPM synchronous motor advances the chart paper through a gear assembly which provides chart speeds of 1, 2, 4, 8 inches per minute, and 1, 2, 4, 8 inches per hour on the Model 680; 2.5, 5, 10, 20 cm/min. 2.5, 5, 10, 20 cm/hr on the Model 680M. This assembly is illustrated in figure 4-3. The chart drive motor drives a cluster of reduction gears with a 2:1 reduction for each of four gears. The speed selector brings the 60:1 speed reducer into mesh with one of the four gears in the cluster. Selection of divisions per minute or hour and also neutral is determined by the gear train control. In the divisions/minute position an idler gear locks the input gear (A) and large spur gear (F) together. (Refer to figure 4-4.) Operation of the 60:1 speed changer is described in paragraph 4-20. In the position just described a 1:1 ratio prevails. When the gear train control is moved to the divisions/hour setting the large spur gear (F) is locked in place. This results in the sun gear and planet gear rotating internally in the 60:1 speed changer thus driving the output gear at a 60:1 reduction. In the neutral position neither the spur gear nor the lock key is engaged; therefore, the input gear rotates freely with no output. This position allows manual advance of the chart.

**4-20. OPERATION OF 60 TO 1 SPEED CHANGER.** The minutes to hours conversion mechanism consists of an epicyclic gear system illustrated in figure 4-4.

A spur gear (A) input to the speed changer serves as the carrier for the planet or idler gear (B). As the carrier gear rotates, the planet gear drives a sun gear (C) which has 60 teeth. The sun gear couples directly to the output spur gear (D) which advances the chart paper. Also in mesh with the orbiting planet gear (B) is a second sun gear (E) with 59 teeth. A modified tooth form permits the gears to mesh. The sun gear (E) is integral with a larger spur gear (F) which has a pitch diameter and number of teeth identical with the input carrier spur gear (A). The design arrangement permits the input carrier gear (A) to rotate free of the integral spur gear (F). When the spur gear (F) is locked in a fixed position by the spine on the control lever, the chart will advance in divisions per hour. When the input carrier (A) and spur gears (F) are locked together by the idler gear on the control lever, the resulting speed of the sun gear (E) will advance the chart in divisions per minute.

#### **MODEL 681, 681M CIRCUIT DESCRIPTION**

**4-21.** The circuit description of the Model 680, 680M also applies to the Model 681, 681M except for those circuits described below. The main circuit difference between the 680 and 681 is in the input circuit and chart drive system.

**4-22. INPUT CIRCUIT.** The input circuit is designed for single range input. This is selected by the customer from any of the ten standard ranges offered on the Model 680. This arrangement requires only two resistors R-109 and R-111. The values are determined by the selected range. R-100 prevents voltages greater than 5 millivolts from reaching the balance circuit.

**4-23. POTENTIOMETRIC INPUT.** This mode of operation is not available on the Model 681 due to the fact that the recorder is designed for a single input range.

**4-24. BALANCE CIRCUIT.** The description under Model 680 is applicable in every way.

**4-25. DAMPING.** The description under Model 680 is applicable in every way.

**4-26. CHART DRIVE SYSTEM.** A sixteen RPM synchronous motor advances the chart paper through a gear train designed to provide a customers selected speed. A second speed is produced by use of the 60:1 speed changer. The chart drive motor drives a gear train which meshes with the 60:1 speed reducer. Selection of divisions per minute or hour (thus two speeds) and also neutral, is determined by the gear train control.

In the divisions per minute position an idler gear is meshed with the speed changer locking the input gear (A) and large spur gear (F) together (refer to figure 4-4). Operation of the 60:1 speed changer is described in paragraph 4-20. In the position just described a 1:1 ratio prevails. When the gear train control is set at divisions/hour setting the large spur gear (F) is locked in place. This results in the sun gear and planet gear rotating in the speed changer thus driving the output gear at a 60:1 reduction. In the neutral position neither the spur gear or the lock key is engaged; therefore, the input gear rotates freely with no output. This position allows manual advance of chart.

#### **MODEL 682, 682M CIRCUIT DESCRIPTION**

**4-27.** The Model 682 is a temperature recording device. Circuit description of the Model 680, 680M is also applicable to the Model 682, 682M except for those circuits described below. The main circuit difference between the 680 and 682 is in the input circuit and chart drive system.

**4-28. INPUT CIRCUIT.** The input circuit consists of a plug-in module incorporating a single cold junction compensated temperature range. A variety of plug-in modules are available for different temperature ranges and thermocouples. A listing of span limits for various thermocouple elements is contained in figure 4-5. The measuring thermocouple is connected to the instrument terminals with leads of the same thermoelectric characteristics as the thermocouple wires. The reference, or cold junction, is then at the recorder terminals where both terminals are at the same temperature. Compensation of the difference in temperature between the measuring junction and reference junction, or changes in temperature of the reference junction, is provided electronically. The positive resistance-temperature characteristic of a nickel wound resistor used in the circuit provides the necessary compensation. This resistor (R100) is mounted on a heat sink common with the reference junction so that it is affected by the same temperature as the reference junction. A change in temperature at the reference junction will

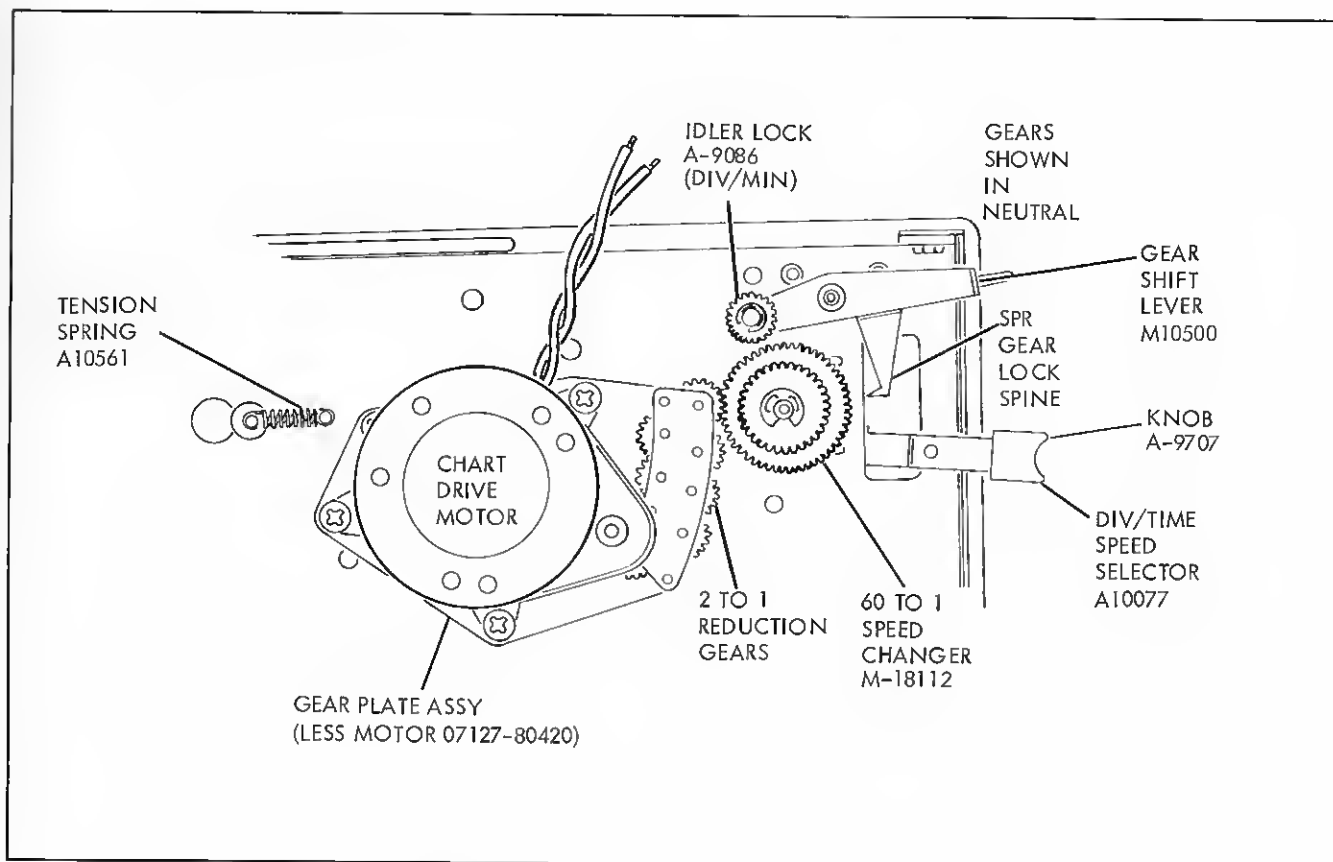


FIGURE 4-3. CHART DRIVE GEAR MECHANISM

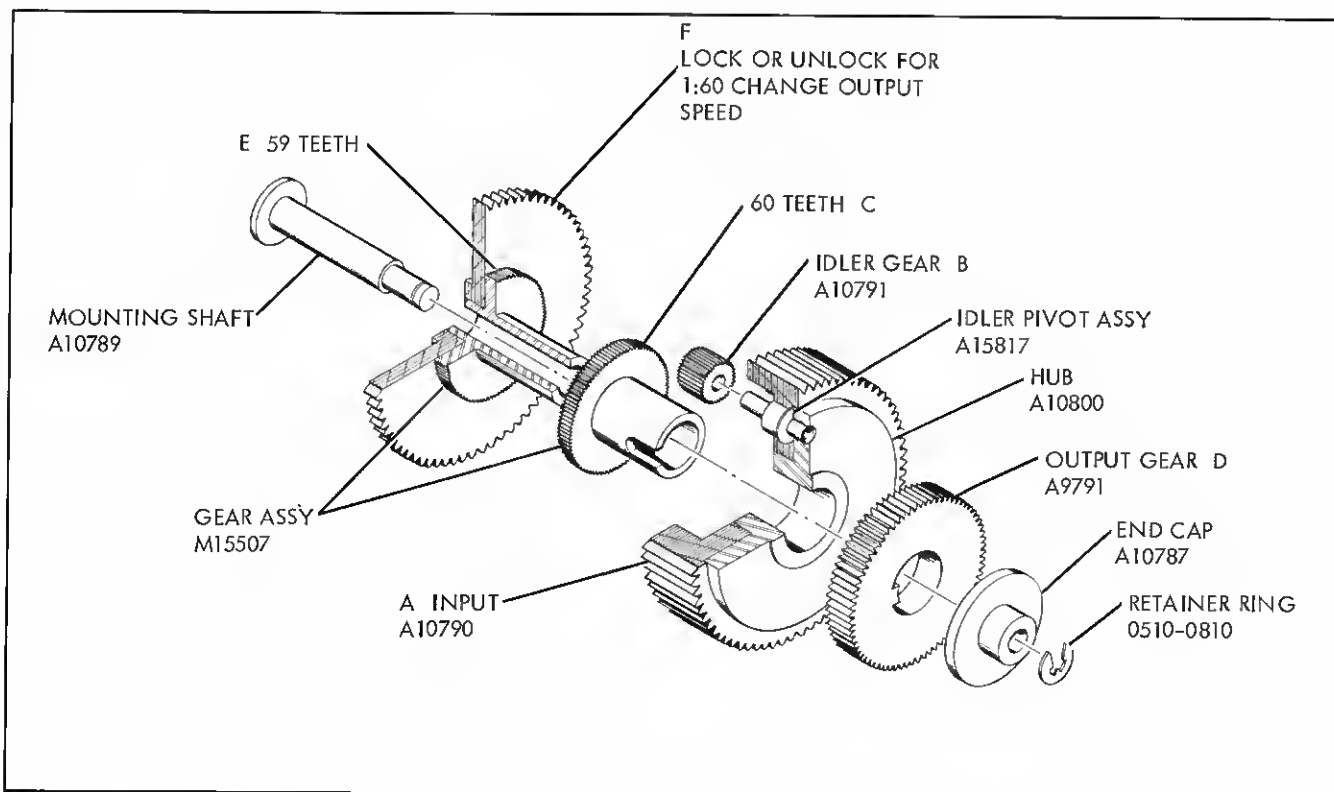
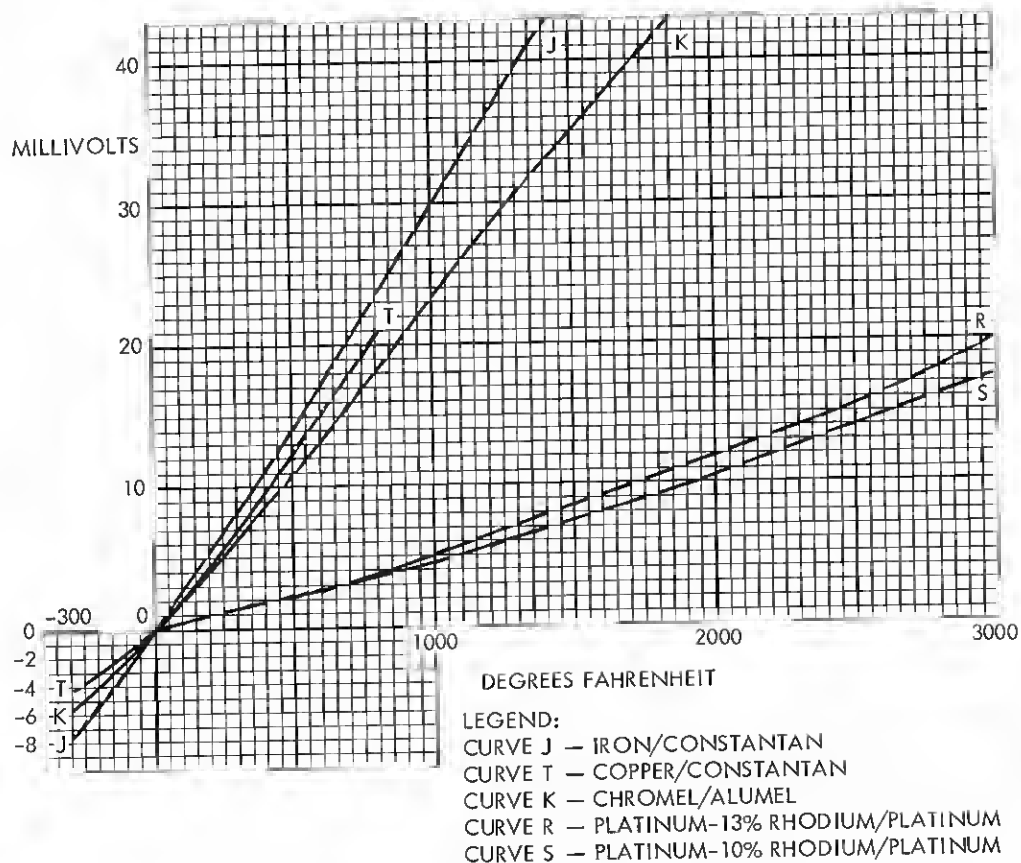


FIGURE 4-4. EPICYCLIC GEAR ASSEMBLY M-18112

SPAN LIMITS FOR COMMONLY USED COLD JUNCTIONS

| TYPE | THERMOCOUPLE ELEMENT               | TEMPERATURE RANGE       |                         | MINIMUM SPAN*     | USE MODULE |
|------|------------------------------------|-------------------------|-------------------------|-------------------|------------|
|      |                                    | CENTIGRADE<br>Min. Max. | FAHRENHEIT<br>Min. Max. |                   |            |
| J    | IRON-CONSTANTAN                    | -200° 760°              | -320° 1400°             | 100°C.<br>200°F.  | TYPE R-2-J |
| T    | COPPER-CONSTANTAN                  | -200° 400°              | -310° 1800°             | 100°C.<br>200°F.  | TYPE R-2-T |
| K    | CHROMEL-ALUMEL                     | -200° 1370°             | -310° 2500°             | 100°C.<br>200°F.  | TYPE R-2-K |
| R    | PLATINUM-PLATINUM<br>(13% RHODIUM) | 0° 1770°                | 32° 3100°               | 500°C.<br>1000°F. | TYPE R-2-R |
| S    | PLATINUM-PLATINUM<br>(10% RHODIUM) | 0° 1770°                | 32° 3215°               | 500°C.<br>1000°F. | TYPE R-2-S |

\*Due to the non-linear response of thermocouples the minimum span may be smaller than the value shown. The limiting factor is not the temperature span but the difference between the thermocouple output voltages at each end of the selected span. This difference voltage must be approximately 5 millivolts, or more.



TEMPERATURE — MILLIVOLT RELATIONSHIPS FOR COMMONLY USED COLD JUNCTIONS  
(32° Reference Junction; See Chart for Correct Input Module)

FIGURE 4-5. THERMOCOUPLE COLD JUNCTION COMPENSATION CHART

produce a change in emf. R100 is supplied with a constant voltage from the recorder reference supply and has a thermal/resistance characteristic which causes the voltage across R100 to change with temperature by just the voltage generated by the reference junction. This voltage opposes the voltage produced at the reference junction and is of equal amplitude, thus blocking both voltages from the amplifier.

**4-29. POTENTIOMETRIC INPUT.** This mode of operation is standard in the Model 682. Potentiometric input provides maximum sensitivity with minimum current drain from the measuring thermocouple. Both models employ this type of operation. Full scale deflection is obtained with the maximum voltage available from the measuring thermocouple. Source impedance must be no greater than 1500 ohms.

**4-30. INPUT FILTER.** Due to the pure DC input no input filter is required on the Models 682 or 682M.

**4-31. BALANCE CIRCUIT.** (Refer to schematic.) The DC input signal is applied to the balance circuit where it is opposed by a DC cancellation voltage from the internal reference supply. The difference between the internal reference voltage and the applied voltage (error signal) is applied to the servo amplifier which drives the servo motor. The rebalance potentiometer, being mechanically coupled to the servo, is driven in a direction to produce a voltage which cancels the error signal produced by the input voltage. The calibrate potentiometer adjusts the calibrate voltage appearing across the rebalance potentiometer so the servo balances at full scale with the maximum voltage received from the measuring thermocouple. Resistance in the balance circuit is sufficiently high for the rebalance potentiometer to impose little current drain on the reference supply, but low in value compared to R-125. This holds the loading and linearity of the balance potentiometer within the accuracy limits of the instrument. DC attenuation by R-119 reduces noise at the rebalance potentiometer R-129 by better than 200 to 1. This noise is predominantly the result of two effects, imperfect contact of the sliders on the resistance element in the rebalance potentiometer during travel resulting in a saw tooth component of noise voltage, and a triboelectric DC voltage generated by friction of dissimilar metals. The zero control introduces into the balance circuit a controlled error signal which is cancelled in the same manner as a regular input error signal. This control provides a means of absolute calibration against a standard signal.

**4-32. CHOPPER AND INPUT TRANSFORMER.** The description in the 680 section (paragraph 3-13) is applicable for the Model 682. However the magnitude of the error signal is not restricted to 5 millivolts.

**4-33. DAMPING.** Capacitor C-105 is in series with the wiper of the rebalance potentiometer R-129. This capacitor draws a charging current wherever a change in input occurs, thus increasing the rate of appearance of the balance voltage across resistor R-119. This phase advance in the slowly varying error signal causes an "anticipatory" approach to the balance point, producing damping.

**4-34. CHART DRIVE SYSTEM.** A sixteen RPM synchronous motor advances the chart paper through a gear train designed to provide a customer selected speed. A second speed is produced by use of the 60:1 speed changer. The chart drive motor drives a gear train which meshes with the 60:1 speed reducer. Selection of divisions per minute or hour (thus two speeds) and also neutral is determined by the gear train control. In the divisions/minute position an idler gear locks the input gear (A) and large spur gear (F) together (refer to figure 4-4). Operation of the 60:1 speed changer is described in paragraph 4-20. In the position just described a 1:1 ratio prevails. When the gear train control is set at divisions/hour setting the large spur gear (F) is locked in place. This results in the sun gear and planet gear rotating internally in the speed changer thus driving the output gear at a 60:1 reduction. In the neutral position neither the spur gear or the lock key is engaged, therefore the input gear rotates freely with no output. This position allows manual advance of chart.

#### MODEL 683, 683M CIRCUIT DESCRIPTION

**4-35.** The Model 683 is a current recording device. Circuit description of the Model 680, 680M is also applicable to the Model 683, 683M except for those circuits described below. The main circuit difference between the 680 and 683 is in the input circuit and chart drive system.

**4-36. INPUT CIRCUIT.** The input circuit is designed for single range input. This is selected by the customer down to a minimum available range of 5 microamperes full scale. This circuit has only a single small value resistor R-111 in shunt with the input terminals.

**4-37. BALANCE CIRCUIT.** The description under Model 680 is applicable in every way.

**4-38. DAMPING.** The description under Model 680 is applicable in every way.

**4-39. CHART DRIVE SYSTEM.** A sixteen RPM synchronous motor advances the chart paper through a gear train designed to provide a customer selected speed. A second speed is produced by use of the 60:1 speed reducer. Selection of divisions per minute or hour (thus two speeds) and also neutral is determined by the gear train control. In the divisions/minute position an idler gear is meshed with the speed changer to lock the input gear (A) and large spur gear (F) together (refer to figure 4-4). Operation of the 60:1 speed changer is described in paragraph 4-20. In the position just described a 1:1 ratio prevails. When the gear train control is set at divisions/hour, the large spur gear (F) is locked in place. This results in the sun gear and planet gear rotating in the speed changer thus driving the output gear at a 60:1 reduction. In the neutral position neither the spur gear nor the lock key is engaged, therefore the input gear rotates freely with no output. This position allows manual advance of chart.

## OPTIONS — CIRCUIT DESCRIPTION

4-40. OPTIONAL ELECTRIC WRITING. The power supply for the optional electric writing provides 28 VDC to the stylus. The 115 VAC power is applied to transformer T-400 which has a center tapped secondary connected to ground. The output voltage is rectified (full wave) by diodes CR-400

and CR-401, and filtered by capacitor C-400. The voltage is regulated by Q-400, R-400, and CR-402 with a constant voltage of 28.5 VDC. The 28.5 VDC is then current regulated by R-401 thru R-403, CR-403, and Q-401 for the servo stylus an independent current regulator R-404 thru R-406, CR-404, and Q-402 is provided for the event stylus.

## SECTION V MAINTENANCE

### 5-1. PREVENTIVE MAINTENANCE

5-2. GENERAL. The Model 680 Series Recorders must be maintained properly to obtain accurate, trouble-free operation. This requires periodic cleaning, performance checks, and visual and electrical checks. In accordance with good maintenance procedures for all precision electronic instruments. Recorders should be protected by covering when not in use.

5-3. ENVIRONMENTAL OPERATION. This instrument is designed to operate over an ambient temperature range of approximately 0°C to 55°C. Operation under other conditions will produce inaccurate results and may cause damage to the recorder. In areas with high humidity, graph paper may become distorted, affecting the accuracy of the grid lines. The area of operation should also be as free as possible of air contamination (soot, smoke, fumes, etc.). Excessive air contamination will require more frequent cleaning.

5-4. CLEANING. Thorough cleaning should be performed periodically. Intervals are determined by type of operation, local air contamination and climatic conditions. Generally, under normal use and conditions, cleaning intervals should be nine to twelve months. Cleaning routine should include the following:

a. Remove the chart magazine and top cover.

b. In inaccessible areas and where there is only dust accumulation, cleaning can be accomplished with an air gun. In more accessible areas and where the air gun will not remove the dirt, dust, or ink, accumulations should be removed with a sponge or cloth saturated in plain soap and warm water, then wiped dry.

c. SLIDER ROD. The slider rod (see figure 5-1) should be kept free of any oils or dust. Spray on Freon (supplied in Accessory Kit) and wipe off with a clean cloth. This should be done every 6 months.

NOTE: The slider rod should be kept clean and free of any lubricant. The "slidewire lubricant" in the Accessory Kit is used as corrosion and wear protection for the balance potentiometer, not for the slider rod.

d. BALANCE POTENTIOMETER. Cleaning and lubrication of the balance potentiometer depends on usage, local air contamination and how critical the user is. For best performance, balance potentiometer servicing should be performed every month. See Section 5-26 for cleaning and lubricating technique.

e. INK SYSTEM. Flush the ink system at least every 500 operating hours or every 90 days. See Section 5-13 for proper procedure.

5-5. LUBRICATION. Every 12th to 18th month, the servo motor pinion drive gear (see figure 7-4) should be greased sparingly with Enco G-350-GL (MIL-G-3278A). This is a high temperature grease designed to remain on the gears even if the motor(s) get hot. Be careful not to get the grease on the balance potentiometer. All other gears and bearings are pre-lubricated by the manufacturer and require no further lubrication.

5-6. VISUAL INSPECTION. During periodic cleaning and lubrication, a routine visual inspection should be performed. The following list is only general and inspection should not be restricted to these items.

1. Check the motor drive gears for proper adjustment ( a slight amount of backlash) and for damaged teeth.

2. Inspect drive cable pulleys for binding.

3. Insure that the servo motor is mounted securely.

4. Check mounting screws on the amplifier and power supply to insure proper contact.



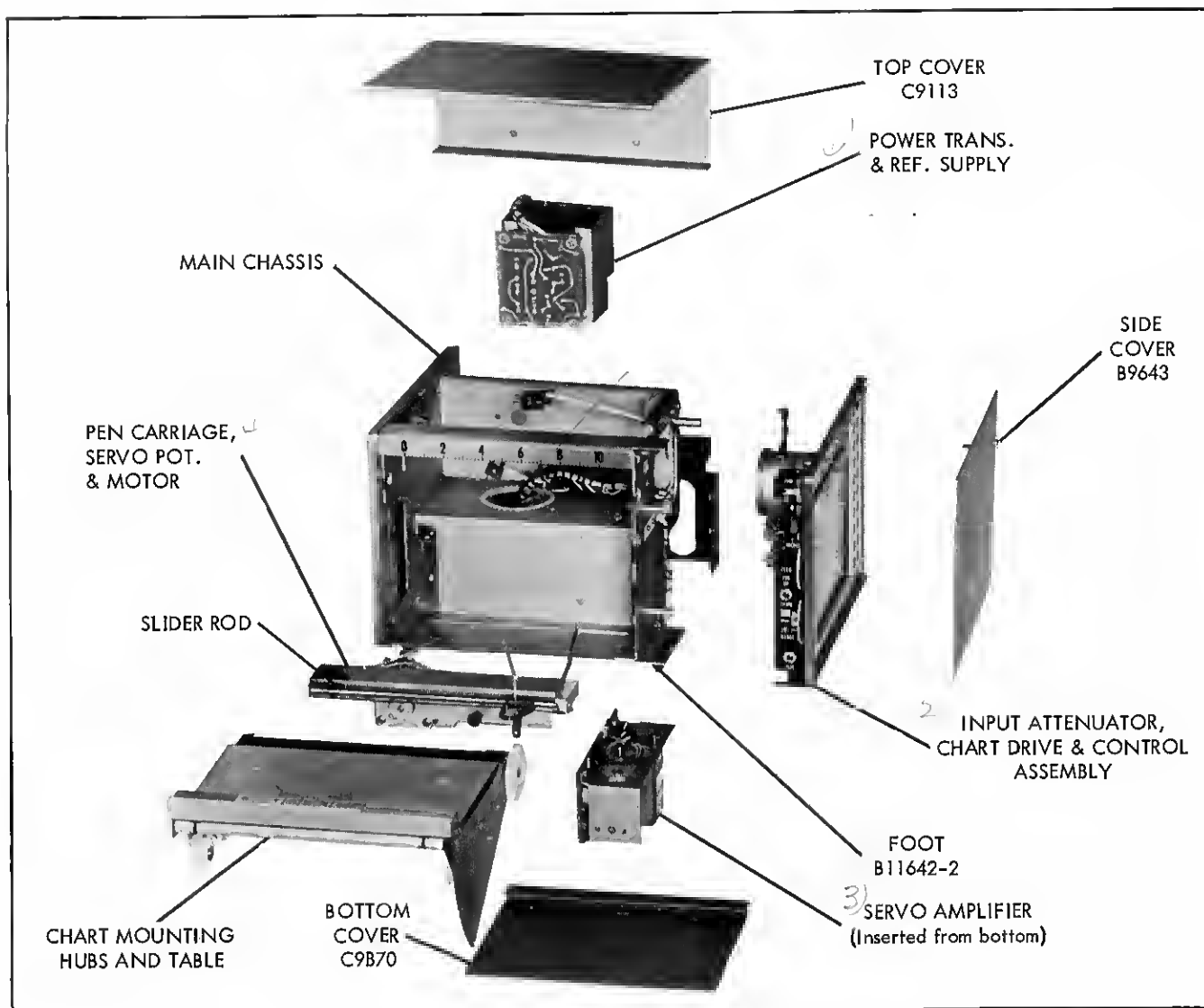


FIGURE 5-1. MAJOR ASSEMBLY DIVISIONS

5. Move pen carriage up and down listening for scrapes, grinding noises, etc., while feeling for any binding in the travel.

6. Check the drive cable for frayed or rubbing cables.

7. A check of components should include inspection for overheating, loose connections, cracked circuit boards, etc.

8. Check the drive chain for wear and damage.

### 5-7. PERFORMANCE CHECKS

5-8. The following performance checks will make the preventive maintenance procedure more effective in finding and eliminating potential problems:

#### a. DEADBAND CHECK.

1. Remove top cover of recorder.
2. Short recorder input.
3. Lower pen and start chart moving at about 2 in./min.
4. Use the zero control to set the pen on a division line on the graph paper.

5. Move the pen a little (less than 0.05") from null by pushing on the pen guard manually. Then slowly release the pen using your fingers as a drag, allowing the pen to return to null. Repeat in the opposite direction. The total deviation between these lines (see figure 5-3) is called deadband and should be no more than 0.1% of full scale (approximately half the width of the ink line). The most frequent reasons for excessive deadband are:

(a) Low gain of servo amplifier (see Section 5-22).

(b) Mechanical drag caused by a dirty slider rod (see Section 5-4, c) or excessive wiper tension.

b. **DAMPING CHECK.** (Note: Always check dead-band first since this will affect damping.) Inspection of the recorder's response to a square wave will indicate recorder damping. The damping may also be checked by manually pushing the pen guard off null and then releasing it. Recorders are adjusted to overshoot between a maximum of 0.1 inch and a minimum of zero (critically damped). The two most frequent causes of poor damping are:

1. Low gain of servo amplifier (see Section 5-23).

2. Mechanical drag caused by a dirty slider rod (see Section 4-4c).

c. **BALANCE POTENTIOMETER CHECK.** A triangular wave drawn at moderate pen speed (1 in./sec) over the full recorder span will reveal a worn or dirty spot on the balance potentiometer. This condition is indicated by rough or jumpy spots which always reappear in the same relative position along the recorder span. See Section 5-26 for cleaning technique.

## 5-9. GENERAL MECHANICAL DISASSEMBLY

5-10. Access to the various components of the recorder is obtained as follows:

A. **CHART MAGAZINE.** Press the lever located below the power switch to the right and swing assembly up into a horizontal position. Now pull the magazine straight out of the recorder.

B. **TOP PANEL:** For servicing slidewire potentiometers, restringing, pen alignment, etc., remove two mounting screws, lift up the back of the panel and slide toward the rear of the instrument. When installing, insert lip of panel under aluminum strip and secure with the two screws.

C. **SIDE PANEL:** Although not usually required, the side panels may be removed as follows. Remove the four mounting screws. On earlier models no screws are visible on the outside and removal of two mounting screws on the inside require removal of the top and bottom cover.

D. **REMOVAL OF PEN ASSEMBLY.** For access to the pen, remove top panel (see paragraph B above) the chart magazine (paragraph A, above) and the trim strip. To remove pen, disconnect ink supply line and remove nut mounting pen to pen holder.

E. **ATTENUATOR AND ZERO POTENTIOMETER REPLACEMENT.** (Model 680 only.) Access to the zero potentiometer and attenuator requires the following:

1. Remove chart drive and recorder control assembly. This assembly mounts the gear train drive, chart drive motor, front panel and input terminals. To remove this assembly, proceed as follows:

a. Remove the right side panel (paragraph 5-10c).

b. From outside the recorder, remove three pan head screws which mount the entire assembly to the chassis.

c. Only limited movement is available due to existing wiring.

2. Use a flat 1/2" open end wrench to loosen locking nut on either the switch or potentiometer.

3. Unloop the drive chain and loosen the set screws holding the drive pulley to the component shaft.

4. Remove the drive pulley and separate the component from the recorder.

5. Unsolder wires and replace with new component.

F. **CHART DRIVE MOTOR REPLACEMENT.** If chart drive motor is to be replaced because of mechanical failure or to allow new chart speeds to be introduced, proceed as follows:

1. Separate the chart drive and recorder control assembly from the recorder chassis (see paragraph E).

2. Unsolder motor leads from terminal strip.

3. Remove the three machine screws holding the chart drive motor to the speed change turret assembly.

4. Remove and replace the motor.

## G. TURRET GEAR SPEED CHANGE ASSEMBLY.

1. Remove the chart drive motor (see paragraph F).

2. Remove the two machine screws and one retaining ring holding the reduction gear and motor mounting bracket to the actuating lever.

3. Individual reduction gears may now be replaced by removing the gear shaft, inserting a new gear, and replacing shaft.

4. Reassemble.

**CAUTION:** After reassembling the turret gear speed changer assembly the hexagonal pivot slide eccentric on which the turret rotates must be adjusted so that the locating notches on the front radius of the turret plate engage the location pin when the gear shift lever is in the corresponding detent position.

**H. 60:1 SPEED CHANGER AND LOCKING IDLER GEAR REPLACEMENT.** These gear assemblies are held in place by retaining rings. Access to them requires removal of the chart drive and recorder control assembly.

**5-11. DRIVE CHAIN LINKAGE REPLACEMENT.** Replacement of a drive chain link may be accomplished as follows: (Refer to figure 5-7).

- a. Remove the chart magazine.
- b. Remove the graph paper.
- c. Separate chain link with a small screwdriver.
- d. A new drive chain link may be installed by snapping new links together.
- e. It may be advantageous to loosen the 2 eccentrically mounted adjustment gears. Proper adjustment is explained in paragraph 5-12.

**5-12. DRIVE CHAIN ADJUSTMENT.** Proper adjustment is necessary for trouble-free operation. Incorrect adjustment can cause excessive wear, incorrect chart speeds, chain breakage, etc. Adjustments are provided in each of 2 eccentrically mounted gears. See figure 5-7.

- a. Loosen the two mounting screws.
- b. Rotate the eccentric mounting with a wrench, if necessary. Rotation should be just sufficient to remove any slack in the chain loop. Over-tightening may cause binding or excessive wear.
- c. When the slack is removed, tighten the mounting screws.

### 5-13. PEN MAINTENANCE

**5-14. PEN CLEANING.** Pen writing failure may be caused by dried ink, sediment, air bubbles in feed line, long disuse, or oil on the pen tip or paper. Dried ink forms brittle crust particles which can build up in the supply line to stop ink flow. Pen assemblies should be cleaned thoroughly at regular intervals (90 days) or before extended storage. (Clean by flushing the system as shown in figure 5-2 with a mild detergent and water, then rinse thoroughly with water and dry with air. The syringe can be used for all these operations.)

### 5-15. STARTING THE PENS

1. Install new cartridge.

2. Start ink flow by placing a finger over the hole in the rubber bulb and then depress the bulb, as shown in figure 3-3. Keep the bulb depressed for several seconds, repeating as required until ink appears at the pen tip.

### 5-16. KEEPING THEM WRITING

1. The pen tip is durable, but extra care should still be used to prevent mechanical damage.
2. Oil or grease on the pen tip will degrade writing. Avoid touching the pen tip.
3. Flush the ink system, as indicated in 5-14 above, at least every 500 operating hours.

### 5-17. FIXING NON-OPERATIVE PEN

A. If the pen will not prime:

1. Check that the cartridge is tight.
2. Check the ink transfer tubing connections for air leaks and inspect the rubber primer bulb for cracks.
3. (a) Squeeze or push pen primer and hold.  
(b) With the other hand, gently squeeze cartridge.  
(c) Release bulb.  
(d) Release cartridge.

Repeat sequence as necessary.

B. If the pen tip is clogged:

4. Connect the syringe to the pen tip with the plastic tube supplied. Withdraw ink from the cartridge. This should cure most stoppages.
5. If step A fails, run water and mild detergent through the pen system with the syringe. Flush system thoroughly with water followed by air. Use a new cartridge.
6. If all else fails, use the pen cleaning wire supplied. Great care should be used to prevent damage to the tip. The wire should be pushed straight in and out. Then flush the pen.

**CAUTION:** The pen tip should never be sanded or machined in any way.

**5-18. PEN PERPENDICULARITY.** One reason for poor or erratic writing (especially in one direction at high speed) is poor perpendicularity between the pen tip and the paper. The adjustment procedure is as follows:

- a. Loosen the mounting screws at each end of the pen carriage bracket.
- b. Loosen the adjusting screw on the left end of the assembly (as viewed from the front of the instrument).

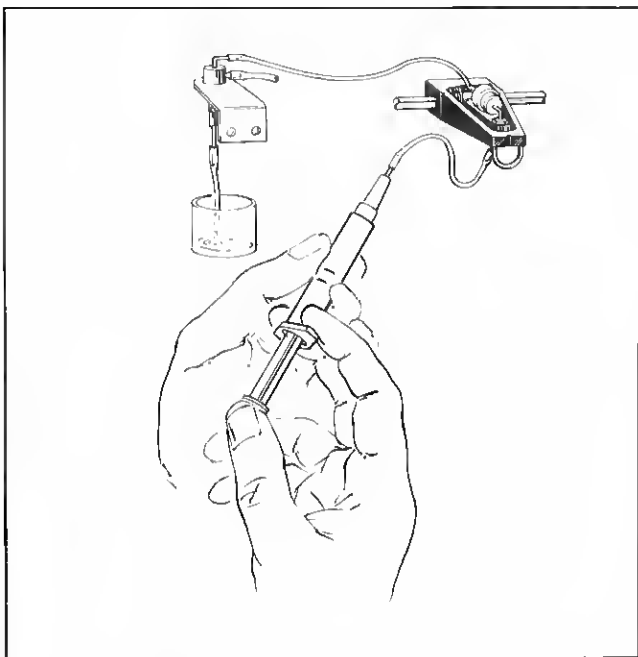


FIGURE 5-2. FLUSHING PEN SYSTEM

c. Push the entire assembly towards the rear of the instrument so the bracket fits firmly against the mounting screws.

d. Tighten the mounting screws.

e. With power applied, rotate the external zero control, if available, or apply a DC voltage to the input terminals to move the pen along one of the graph grid lines. Note any deviation.

f. Loosen the left hand mounting screw and turn the adjusting screw CW (as viewed from the rear of the instrument) while still driving the pen along the grid line, until the pen properly tracks the grid line.

**5-19. PEN LIFT ADJUSTMENT.** Travel adjustment of the pen carriage in either the raised or lowered position is provided by a set screw attaching the pen lift transfer arm to the solenoid plunger. Access to this bristol set screw is obtained by removing the top panel. Adjustment is made by loosening the set screw and sliding the arm forward on the shaft (towards the front of the recorder) to lower the pen, or backwards on the shaft to raise the pen. In the lowered position the pen should rest flat on the paper.

#### 5-20. PEN TRAVEL ADJUSTMENT.

a. Remove the chart drive and chart magazines.

b. Loosen set screw holding the drive sheave to the motor drive unit.

c. Position the pen approximately  $1/32$  of an inch to the right of the full scale mark.

d. Manually rotate the drive sheave so the three-turn stop mechanism is at its maximum CCW position as viewed from the front of the instrument.

e. Tighten the set screw in the drive sheave.

f. Repeat to verify positioning as required.

### 5-21. ELECTRICAL MAINTENANCE

**5-22. POTENTIOMETRIC OPERATION.** This mode of operation provides essentially infinite input impedance at null. All troubleshooting done on the Model 680 Series Recorders should be performed with the input(s) connected to a voltage source with very low noise or else shorted. Failure to do this may give erratic operation, including excessive dead-band, slow response speed, and poor damping. To convert the Models 680 and 680M to potentiometric operation, a bus wire located on the input circuit board must be removed (refer to figure 7-9). Removal of this wire disconnects the shunt resistor across the input terminals. Both Models must be operated with the range selector in the 5 mv or 6 cm range. Source impedance should be no greater than 1500 ohms. This mode of operation may require an initial increase in gain setting to reduce servo dead zones. Full scale deflection is obtained with 5 mv on Model 680 and 6 mv on Model 680M.

**NOTE:** When operating in potentiometric mode the servos will not null without a load connected across the input terminals.

**5-23. GAIN ADJUSTMENTS.** The gain control potentiometers are located on the servo power amplifier. The gain control primarily affects Recorder's dead-band. Dead-band is the amount the measured quantity can be varied without initiating pen response. Because the gain control affects damping and recorder accuracy the gain control should be properly adjusted before damping is checked or calibration adjusted. The gain adjustment should be set (with a common tip screwdriver) no higher than necessary for firm servo control.

a. Extend the chart magazine to its last position ( $30^\circ$ ) to obtain access to the gain potentiometer.

b. Set the chart speed at lowest speed available.

c. Connect an accurate voltage source to the input terminals and regulate the voltage until the pen is in exact agreement with midscale.

d. Manually move the pen off null approximately  $1/10''$  (2.5mm). Allow pen to return to null slowly. Do not simply release it. Repeat this operation in the opposite direction. The trace should appear similar to (c) in figure 5-4. If the pen does not return to the original setting as shown in (a) of figure 5-4, the gain is too low. Oscillation of the pen and excessive over shoot as illustrated in (b) of figure 5-4 indicates excessive gain.

e. Rotate gain adjustment screws CCW to decrease the gain and CW to increase it (as viewed from the front of the recorder). A long common tip screwdriver is required to make the adjustment from the front. Repeat step "d".

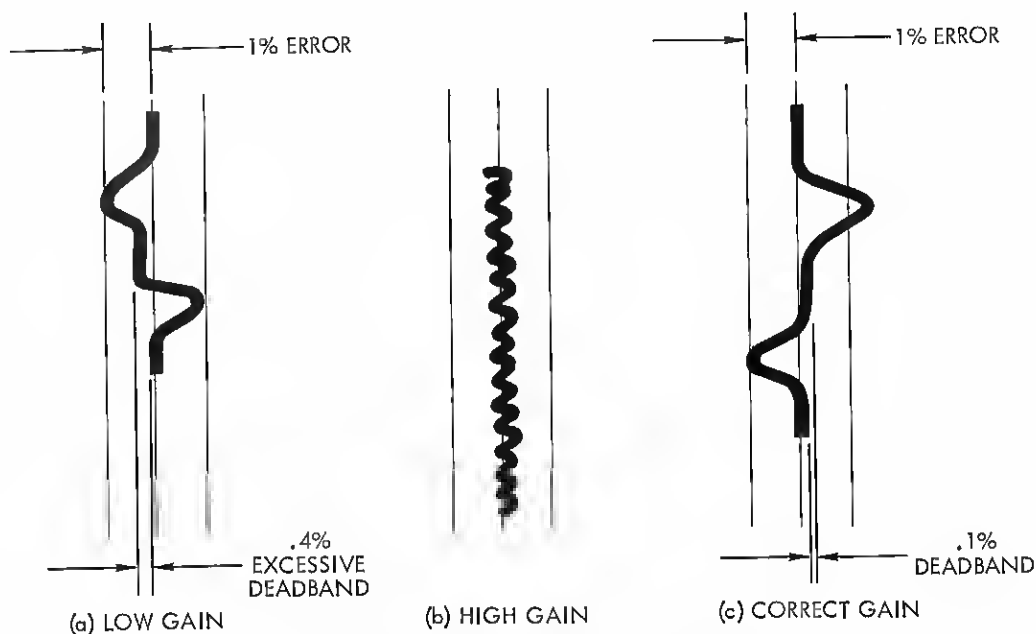


FIGURE 5-3. GAIN ADJUSTMENT CHART

f. Repeat above procedure until trace similar to (c) of figure 5-4 is obtained.

**CAUTION:** Setting the gain control too high will overheat the recorder. This may degrade the writing of the recorder (by changing the ink viscosity) and shorten the life of various components.

5-24. CALIBRATION. Reference voltage is Zener controlled, regulated, and temperature compensated. Drift or variation should be negligible. In the event calibration inaccuracies do appear, first check servo amplifier gain, Section 5-23. Recalibration may be accomplished as follows:

#### A. MODELS 680 AND 680M.

1. Remove the bottom cover to gain access to the calibrate control R-128.
2. Set the range switch to 1 volt full scale.
3. Adjust the zero control to bring pen to exactly "0" (left edge of graph).
4. Connect an accurately established one volt DC (as obtained, for example, from an H-P Model 740 DC Standard), to the input terminals. This signal will drive the pen to the right edge of the graph.
5. Adjust the calibration controls to bring pen into exact agreement with the full scale marking

on the scale. Removal of the input signal should cause the pen to return to its original "0" position. Repeat calibration procedures until accurate repositioning is achieved.

6. In the event full scale cannot be reached by use of the calibration controls, the electronic reference supply should be checked for an output of approximately 6.25 volts ( $\pm 5\%$ ).

#### B. MODELS 681 AND 681M.

1. Remove the bottom cover to gain access to the calibrate control R-128.
2. Adjust the zero control (internal adjustment) to bring pen to exactly "0" (left edge of graph).
3. Connect to the input terminals an accurately established DC voltage equivalent to the customer selected value required for full scale deflection. An L & N precision potentiometer and Weston Standard Cell is an accurate source for this voltage. This signal will drive the pen to the right edge of the graph.
4. Adjust the calibration control to bring pen into exact agreement with the full scale marking on the scale. Removal of the input signals should cause the pen to return to its original position. Repeat calibrated procedures until accurate repositioning is achieved.

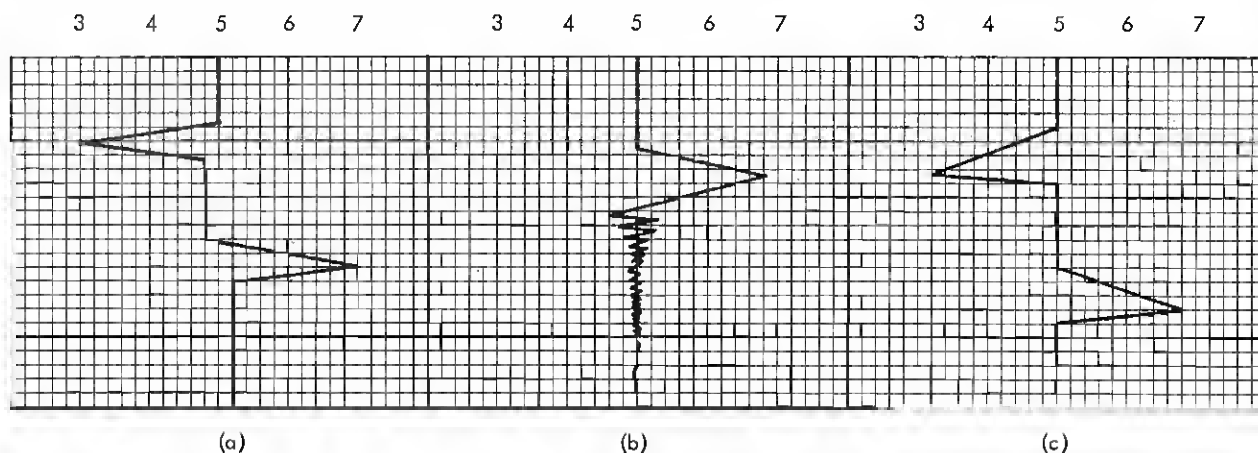


FIGURE 5-4. GAIN ADJUSTMENT CHART

5. In the event full scale cannot be reached by use of the calibration controls, the electronic reference supply should be checked for an output of approximately 6.25 volts ( $\pm 5\%$ ).

#### C. MODEL 682 AND 682M (SPAN CALIBRATION).

1. Determine the millivolt equivalents for maximum and minimum temperatures for the thermocouple type employed. A reference table is available in the National Bureau of Standards, Standard Reference Tables for Thermocouples (Circular 561, dated 1955). Determine the full scale voltage span required by the recorder.

2. Remove the top, bottom and side panels.

3. Disconnect the measuring thermocouple from the input terminals. Energize the recorder.

4. Connect to the input terminals an accurate variable millivolt supply. Adjust this signal to place the pen in exact agreement with the left hand edge of the graph. Note the voltage required.

5. Designating the voltage determined in step 4 as "OFFSET", algebraically add it to the full scale span voltage determined in step 1. The algebraic sum of these voltages should drive the pen to exactly full scale at the right edge of the graph.

6. Using the calibration potentiometer, adjust the pen position until exact agreement with the full scale mark is achieved.

7. Recheck the low end of the scale (left edge) by reapplying the voltage determined in step 4. If a shift is noted, repeat calibration procedures from step 4 through step 7 until accurate repositioning is achieved.

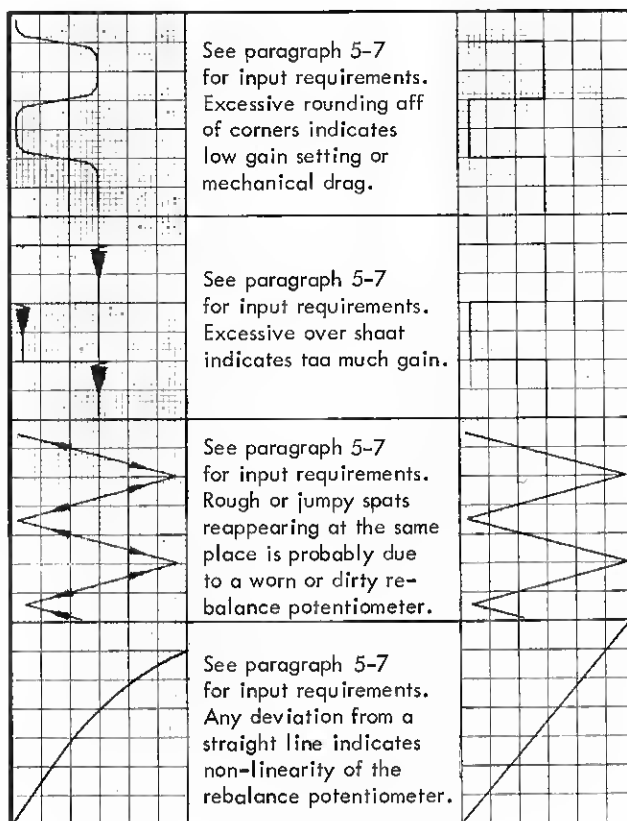


FIGURE 5-5. PERFORMANCE CHART

#### D. MODEL 682 AND 682M (ZERO CALIBRATION).

1. Instruments with spans including  $0^{\circ}\text{C}$ . This adjustment runs concurrent with the span calibration.

(a) Disconnect the millivolt supply used in the span calibration and reconnect the thermocouple to the input terminals.

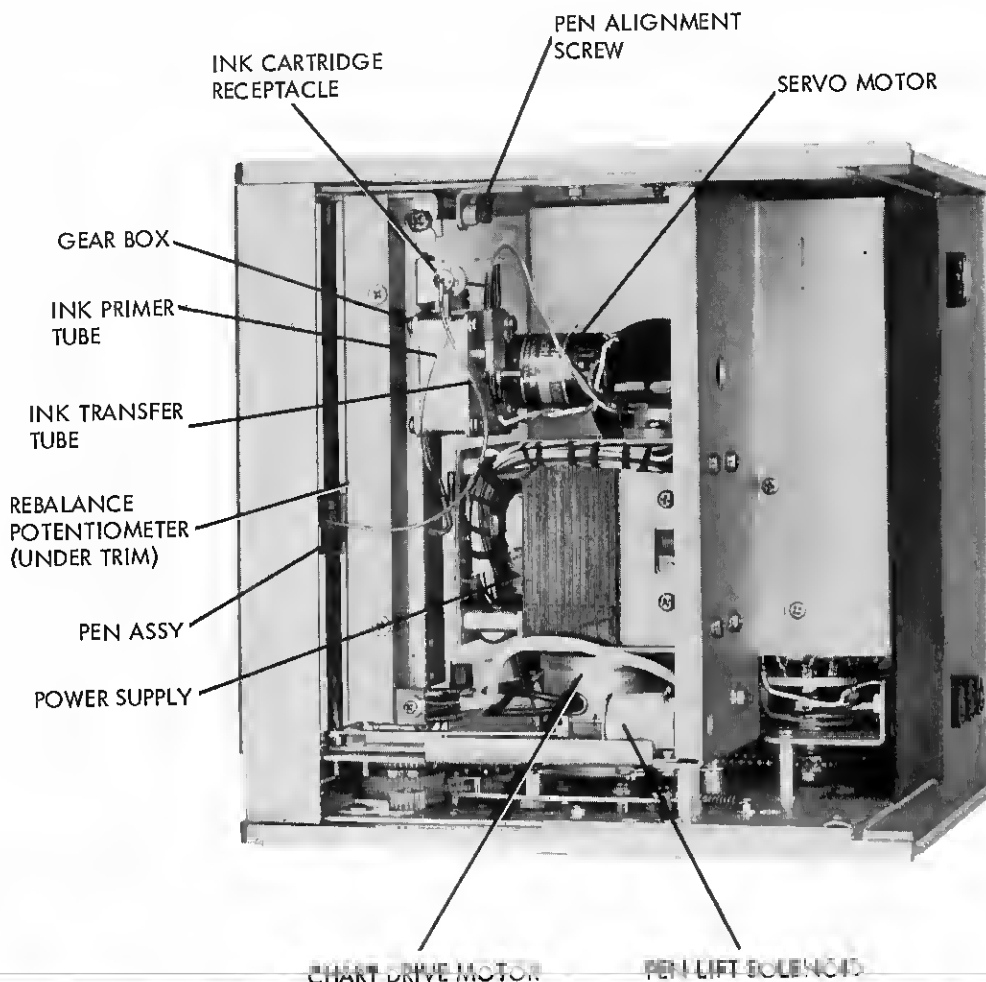


FIGURE 5-6. TOP VIEW OF MODEL 680

**NOTE:** Observe thermocouple polarity. Polarity is correct when an increase in temperature of the thermocouple causes up-scale movement of the recorder pen.

(b) Using the internal zero potentiometer, adjust the pen position to read the known temperature of the measuring thermocouple. This is conveniently done by immersing the measuring thermocouple in a mixture of ice and water and setting the pen at  $0^{\circ}\text{C}$  ( $32^{\circ}\text{F}$ ).

(c) This completes the calibration of the 682 or 682M with  $0^{\circ}\text{C}$  within the span.

.2. Instruments with spans not including  $0^{\circ}\text{C}$ . This adjustment runs concurrent with the span calibration.

(a) Accurately determine local room temperature. Determine the millivolt equivalent for this temperature from the NBS reference tables for the

thermocouple type being used. Subtract this value from the millivolt value of the low end of the scale as determined in step "C4" of the span calibration procedure.

(b) From an accurate millivolt supply, apply the voltage determined in step (a) to the recorder input terminals.

(c) Using the internal zero potentiometer, adjust the pen position to exact agreement with the left hand edge of the graph (low end of scale).

(d) Disconnect the millivolt supply and reconnect the thermocouple to the input terminals.

**CAUTION:** Observe thermocouple polarity. Polarity is correct when an increase in temperature causes up-scale movement of the recorder pen.

(e) This completes the calibration of the 682 or 682M with  $0^{\circ}\text{C}$  out of the recorder span.

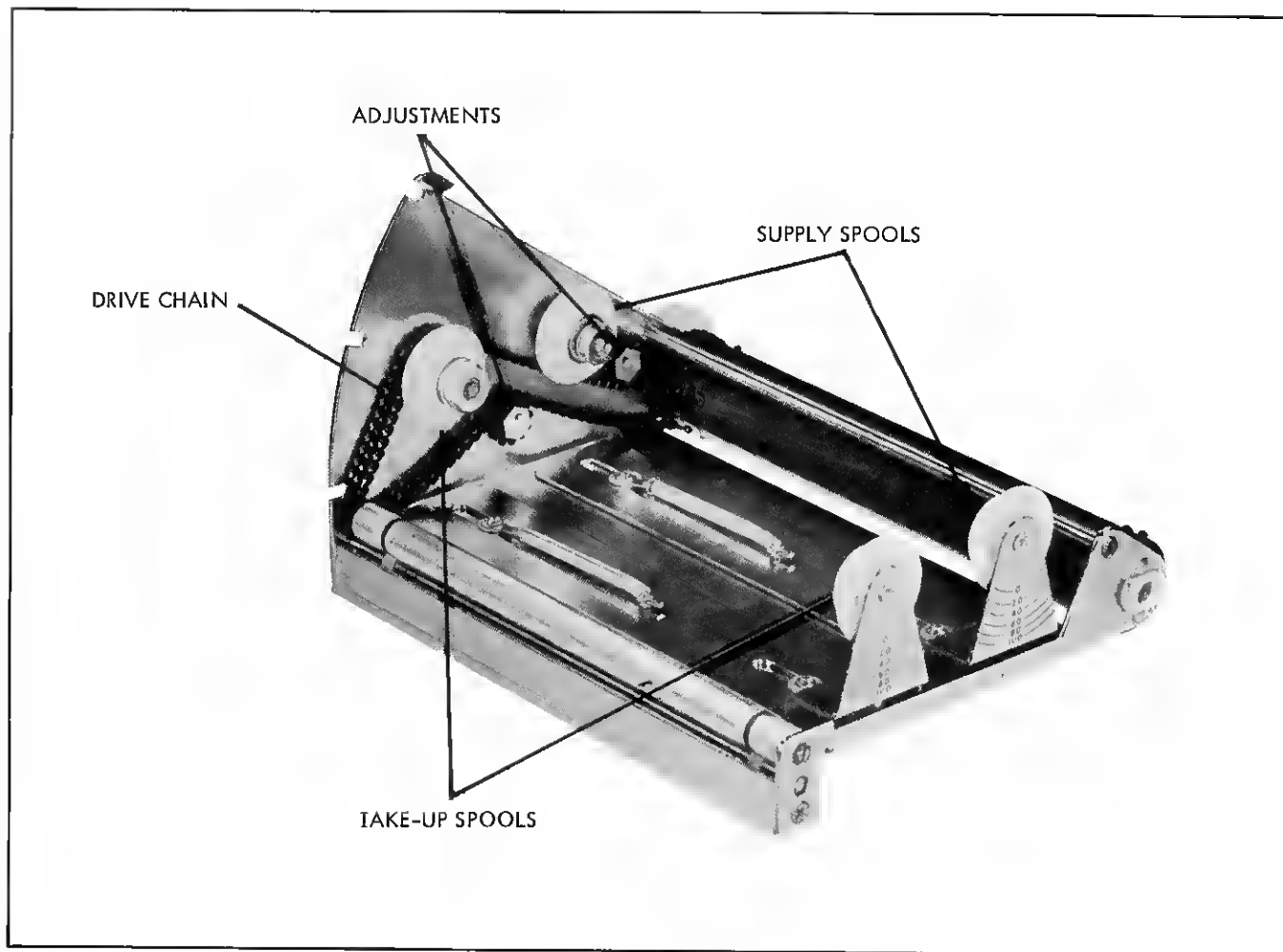


FIGURE 5-7. CHART MAGAZINE

#### E. MODELS 683 AND 683M.

1. Remove the bottom cover to gain access to the calibrate control R-128..

2. Connect a precision 1000 ohm resistor in series between the positive input terminal of the 683 or 683M and an accurate DC voltage source. Ground the negative terminals.

3. Connect a precision differential voltmeter, such as the Hewlett-Packard Model 741A, across the 1000 ohm resistor.

4. Adjust the internal zero control to bring the pen to exactly "0" (left edge of graph).

5. Calculate by ohms law the voltage drop which will develop across the precision resistor at full scale by multiplying the current value of the full scale span by the value of the precision resistor (1000 ohms).

6. Adjust the DC voltage source until a differential voltmeter reads the voltage calculated in step #5. This voltage should drive the pen to full scale.

7. Adjust the calibrate control to bring the pen into exact agreement with the full scale marking. Removal of the input signal should cause the pen to return to its original "0" position. Repeat calibration procedures until accurate repositioning is achieved.

8. In the event full scale cannot be reached by use of the calibration control, the electronic reference supply should be checked for an output of approximately 6.25 volts ( $\pm 5\%$ ).

5-25. **DAMPING CHARACTERISTICS.** No damping adjustments are provided. A fixed damping circuit designed to provide slightly underdamped operation is described in Section IV, paragraph 4-14. Proper gain settings are necessary to produce optimum performance.

#### 5-26. **BALANCE POTENTIOMETER MAINTENANCE**

5-27. **BALANCE POTENTIOMETER CLEANING.** Fundamental to the high accuracy of self-balancing servo recorders is the balance potentiometer. Contamination of the balance potentiometer by wear products, or frictional polymers, results in irregular or "jumpy" plots as the pen passes the particular position(s) contaminated. When this occurs, perform the following check:



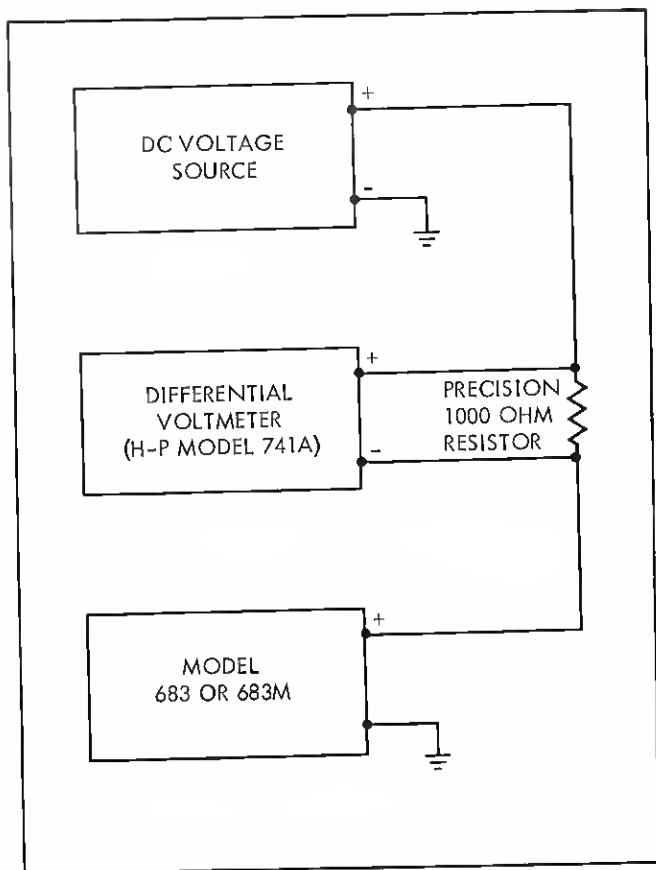


FIGURE 5-8. CALIBRATION HOOKUP DIAGRAM OF MODEL 683

- a. Short the rear input terminals of the Recorder.
- b. Move the pen through a full excursion using the zero control. If the pen appears "jumpy" at one or several precise positions, then the balance potentiometer must be cleaned. (Note: It is possible for the zero potentiometer itself to be noisy rather than the balance potentiometer.)
- c. Remove the chart magazine to gain access to the pen balance potentiometer (see figure 5-1). To clean, spray on cleaner (from Recorder accessory kit) and wipe the resistance element at right angles to the length of the potentiometer and lengthwise on the return buss. Kimwipes, or lint-free tissue works well. Immediately apply the balance potentiometer lubricant from the accessory kit to both the slidewire and return buss to protect the potentiometer from wear.
- d. If noise is not apparent with shorted input check incoming signal for excessive noise.

**5-28. WIPER INSPECTION, ADJUSTMENT, AND REPLACEMENT.** Ordinarily, the balance potentiometer wiper does not require adjustment, but a quick check for adjustment and wear should be made when a good compromise between dead-band and smoothness of writing (too much noise) cannot be found, or when the balance potentiometer requires more frequent cleaning than when new.

a. Remove the rebalance potentiometer (see paragraph 5-29). This allows access to the wiper mounting screw on the pen carriage.

b. After step a, the wipers will be in clear view. Check for dirt or contamination build up on contact surfaces. Compare the wiper with that of figure 5-9, which has excess wear. Normally only the wiper must be replaced. The wipers can then be removed with a small screwdriver.

c. To check wiper adjustment, move the pen block until its lip just touches the edge of the scale mount extrusion. In this position, both wiper fingers should have just made contact with the return buss and the resistance element. If the wiper does this correctly, then when the wiper block is returned to the slot in the back of the scale, the wipers will have the correct contact pressure against the balance potentiometer. The wipers can be adjusted by carefully lifting or pushing them.

**5-29. BALANCE POTENTIOMETER REPLACEMENT.** Replacement of the balance potentiometer (mandrel) is generally due to physical damage rather than wear.

1. Remove the top cover and chart magazine as described in paragraph 5-10 A and B.
2. Remove the potentiometer cover mounted by two screws.

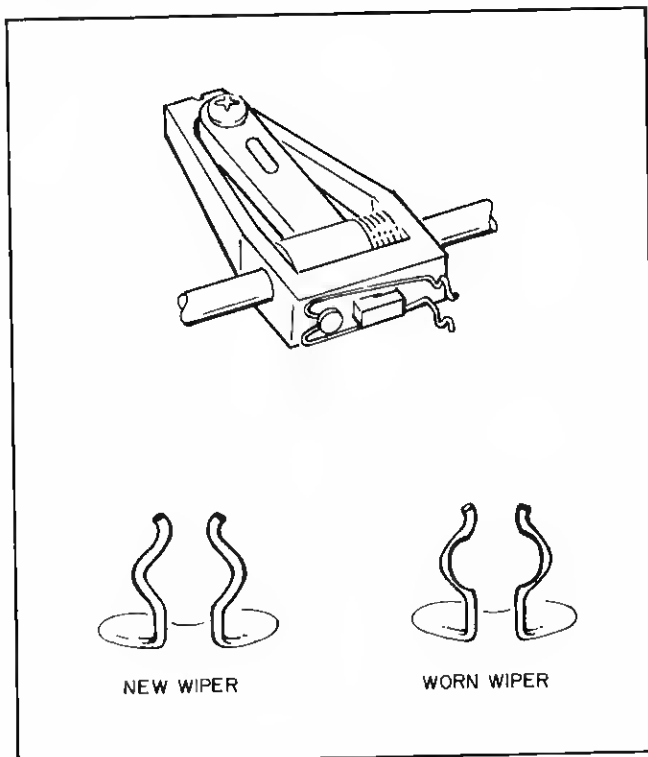


FIGURE 5-9. WIPER INSPECTION

3. Unplug the electrical connection from the servo system.

4. Remove the three screws mounting the potentiometer to the bracket and remove the potentiometers.

**CAUTION:** Care should be exercised in removal of the potentiometer to prevent damage to the slidewire or wiper. When reinstalling, both wiper contacts should be carefully placed on the appropriate mandrel or solid wire.

### 5-30. SERVO MOTOR MAINTENANCE

5-31. After several days of storage, a slight improvement in retrace characteristics may be produced by several high speed full scale excursions.

5-32. **SERVO MOTOR BRUSH REPLACEMENT.** It is not recommended that worn out motor brushes be replaced. By the time the motor brushes need replacement, other motor components will probably also need replacement. It is therefore recommended that the entire motor be replaced with new units. However, if it seems advisable to replace the brushes, follow the steps listed below. It is possible to install new brushes without removing the motor from the recorder, depending upon the angular position of the motor. If the motors are to be removed, refer to Paragraph 5-35, then proceed as follows:

a. Remove the two solder lug mounting screws. (Note the polarity of the lugs and mark to avoid a phase reversal when reassembling.

b. Pivot the brush springs outward and pull the brushes out of their holes.

c. Clean the brush holes and install new brush assemblies, H-P No. A-18671. Note: Position new

brushes so the arc on the bottom of the brush matches the curvature of the commutator.

d. Swing the springs back to their original position and hook under the flange on the solder lug.

e. Make sure the brush can move down without its lead interfering. Reinstall the motor as described in Paragraph 5-35.

### 5-33. CORRECTION OF STICKING MOTOR BRUSHES.

The most common cause of a sticking motor brush is an interference between the motor body and the brush lead wire, preventing the brush from moving downward. By carefully repositioning the lead, the brush can be freed. Other possible causes of a sticking brush are burrs in its hole or an accumulation of foreign matter. If either of these are the cause, the motor will have to be removed and cleaned or replaced.

5-34. **SERVO MOTOR GEAR MESH ADJUSTMENT.** Excessive backlash of the servo gear drive system may be corrected as follows:

a. Loosen the three mounting screws on the motor mounting bracket.

b. Rotate the eccentrically mounted motor until the drive gear meshes properly with the motor spline without binding. A small amount of backlash is necessary.

c. Retighten the mounting screws.

5-35. **SERVO MOTOR REPLACEMENT.** Should replacement of the DC servo motor be indicated, proceed as follows:

a. Remove the servo potentiometer and motor assembly. Located in the upper front portion of the recorder, this assembly includes the rebalance

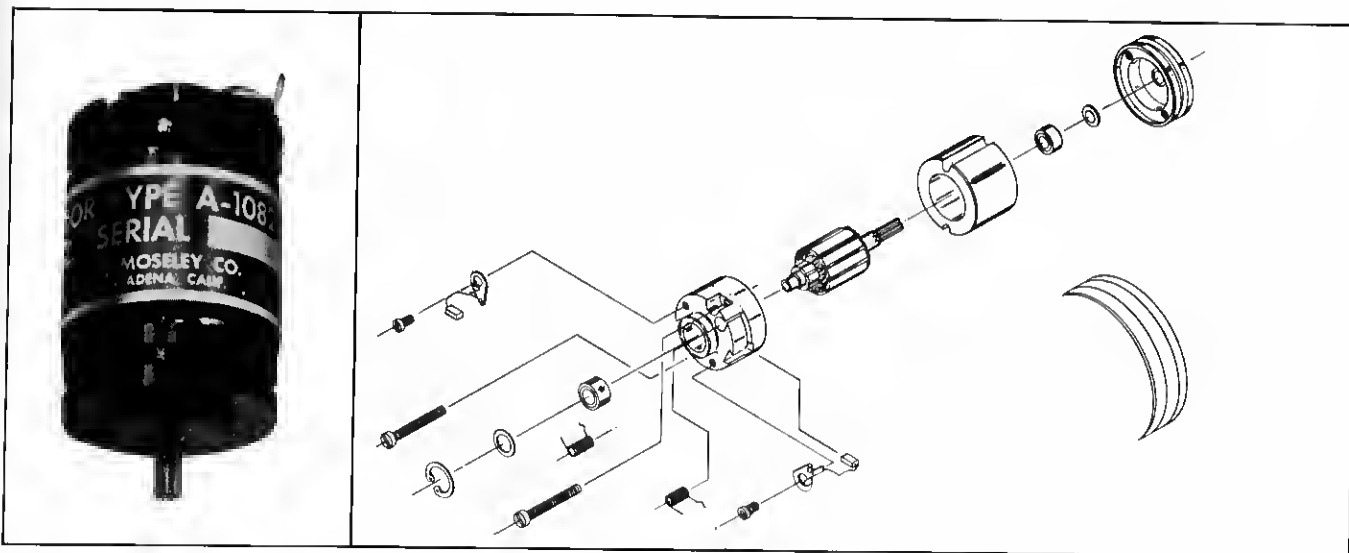


FIGURE 5-10. SERVO MOTOR

potentiometer, servo motor, recording pen and ink cartridge.

1. Remove the top cover and chart magazine.
2. Separate the two connectors, one attached to the potentiometer, the other to the servo motor.
3. Loosen the screws holding each end of the entire assembly to the recorder chassis.
4. Release the mechanical connection to the pen solenoid.
5. Slide the assembly forward, down, and out through the front of the recorder.

**CAUTION:** After servicing this assembly, the pen should be aligned to move perpendicular with the chart advance. Refer to paragraph 5-18.

- b. Unsolder motor leads from terminals.
- c. Loosen the three screws mounting the servo motor to the motor drive unit and turn the mounting clips out of the way.
- d. Pull the servo motor to the rear of the assembly separating the splined motor shaft from the motor drive unit gear and clutch assembly.
- e. Install new servo motor and adjust backlash (see paragraph 5-35).

### 5-36. RESTRINGING INSTRUCTIONS

5-37. **DISASSEMBLY.** To restring any of the 680, 681, 682 or 683 series, the top cover and chart magazine must be removed.

5-38. **MATERIALS REQUIRED.** Before attempting to restring to recorder, the following materials should be available:

- a. Nylon cable assembly, H-P Part No. 8160-0050 20' long.
- b. Washer, H-P Part No. A-10677.
- c. Spring, H-P Part No. A-10678.

### 5-39. RESTRINGING PROCEDURE.

- a. Remove the servo potentiometer and motor assembly (see paragraphs 5-29 and 5-35).

b. Place the assembly in an inverted position with the motor away from the operator, as illustrated in figure 5-11.

c. Move the pen to the right end of the drive movement.

d. Insert one end of a piece of nylon drive cable at least 20 inches long through the pen block stud (E), tension spring (F), and washer (G).

e. Proceed from this assembly point (A) around the pulley (B) to drive sheave (C). The drive sheave should be positioned against its stops in the CW direction. The small hole in the drive sheave should be approximately horizontal.

f. Proceed CCW approximately  $1/4$  turn around the drive sheave and insert the cord through the hole in the drive sheave from the right side.

g. Pull through all slack and wind  $3-1/4$  turns around the drive sheave in a CCW direction.

h. Continue around pulley (D) and back to assembly point (A).

i. Insert this end of the cord through the stud assembly, spring and washer.

j. Loosen the starting end of the cord from the washer (G) and take up slack by drawing on both ends at once.

k. With the tension spring in compression and the washer flush with stud (E), tie the ends of the cord together in a knot large enough to prevent slipping through the retaining washer (G).

l. Manually move the pen across the recorder carriage. Make sure that the stop assembly in the motor drive unit does not terminate the pen movement before full scale travel has been permitted.

### 5-40. TROUBLESHOOTING

5-41. **GENERAL.** Troubleshooting of the 680 series should be performed in a logical manner. The concept of bracketing should be employed, i.e., establishing circuits or sections which are not operating or are operating abnormally. This is generally the fastest way to locate trouble in a closed loop circuit. The block diagram in Section IV should be utilized for localizing trouble.

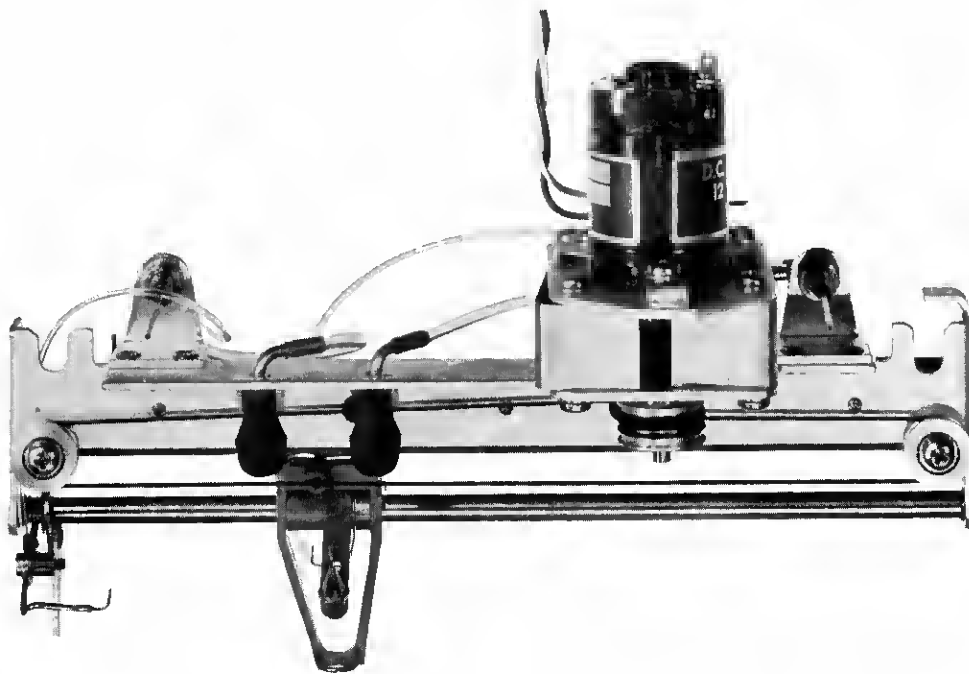
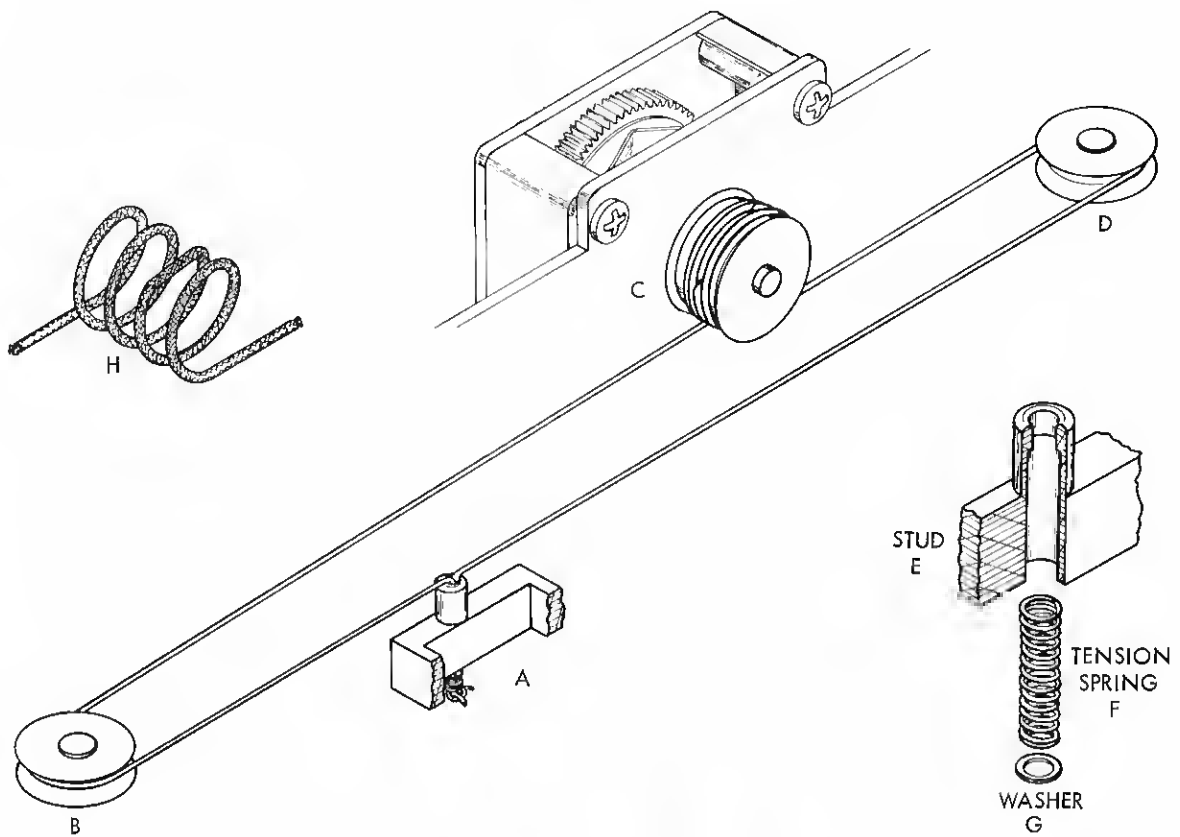


FIGURE 5-11. RESTRINGING DIAGRAM

| PROBLEM   | POSSIBLE CAUSE  | CURE   |
|---|---|--|
| 1. Noisy or rough trace.  | 1. Instrument not grounded.<br>2. Worn or dirty potentiometer.<br>3. Insufficient contact pressure or improper positioning of wiper on slidewire balance potentiometers.<br>4. Noisy transistors in amplifier.<br>5. Defective zener diode. | 1. 115/230 VAC power GND required.<br>2. See paragraphs 5-26 and 5-27 for tests and corrective procedures.<br>3. Contact at 45° angle before installation with contact pressure of 15 grams (approximate values).<br>4. Check TP-2; if noise is present, check TP-1. This will localize the trouble to a few components.<br>5. Replace diode CR-311. |
| 2. One position of the pen produces excessive jitter that repeats each time the pen reaches this position.  | Dirty balance potentiometer   | Clean per Section 5-26.  |
| 3. Excessive pen jitter (small amplitude).<br><br>NOTE: If 1 or 2 occurs very frequently, the balance potentiometer wiper may need adjustment or be badly worn. See Section 5-28. | a. Excessive input signal noise<br>b. Dirty balance potentiometer.<br>c. Servo amplifier gain set too high.   | a. Short recorder input to see if jitter stops.<br>b. Clean per Section 5-26<br>c. Decrease gain per Section 5-23.   |
| 4. Pen skips when writing at high speed.  | a. Poor perpendicularity between pen tip and chart paper.   | a. Adjust per Section 5-18.<br>b. Replace.   |
| 5. Pen won't prime.   | a. Cracked rubber primer bulb.<br>b. Cartridge not secure.<br>c. Ink supply tubing not connected tightly.   | a. Replace.<br>b. Replace cartridge if loose (see 3-21).<br>c. Push tubing further on fittings with fingers.   |
| 6. Pen stops writing.   | a. Clogged with sediment or paper fiber in pen tip.<br>b. Oil or grease on pen tip (from touching with fingers).<br>c. Clogged primer air line.   | a. Using syringe and tubing in accessory kit. Withdraw ink from pen tip. (See figure 5-2.)<br>b. Clean (Section 5-14).   |

FIGURE 5-12. TROUBLESHOOTING CHART (SHEET 1 OF 2)

| PROBLEM   | POSSIBLE CAUSE  | CURE  |
|---|---|---|
| 7. Bubbles in ink supply line.                          | a. Recorder overheated due to excessive noise on input signal or servo amplifier gain set too high.                                       | a. Check servo gain per paragraph 5-23.   |
| 8. Excessive deadband (poor notch, poor resettability). | a. High noise content on input signal (60 Hz).<br>b. Excessive drag because of dirty slider rod.<br>c. Low servo amplifier gain.          | a. Short input to check.<br>b. Clean with Freon supplied in accessory kit.<br>c. Adjust per Section 5-23.                         |
| 9. Recorder response slow.                              | a. High noise on input signal.<br>b. Servo gain control set very low.<br>c. Drag due to dirty slider rod.<br>d. Excessive wiper pressure. | a. Short input to check.<br>b. Adjust (Section 5-23).<br>c. Clean with Freon supplied in accessory kit.<br>d. See paragraph 5-28. |
| 10. Damping poor. More than 0.1 inch overshoot.         | a. Servo amplifier gain set too low.<br>b. Damping capacitor C-105 open circuited.  | a. Adjust per Section 5-23.<br>c. Remove and check.   |
| 11. Chart speeds slower than settings.                  | a. Chain too tight.   | a. See chain drive adjustment, paragraph 5-12.  |

FIGURE 5-12. TROUBLESHOOTING CHART (SHEET 2 of 2)

## SECTION VI REPLACEABLE PARTS

### 6-1. INTRODUCTION

6-2. This section contains parts list, one year isolated spare parts list, mechanical parts identification, and ordering information.

### 6-3. PARTS LIST

6-4. Figure 6-1 lists parts in alphanumeric order by schematic circuit symbols. Parts not designated on the schematics are listed at the end of figure 6-1 under a separate sub-heading. There is only one parts list for the entire 680 series. Model numbers with applicable part numbers and description are provided for each symbol. Model numbers include metric units and options unless otherwise specified.

### 6-5. RECOMMENDED SPARES

6-6. Figure 6-2 lists all components with mortality experience. Recommended quantities to stock for

maintaining the instrument for a one year period are designated in the RS column.

### 6-7. MECHANICAL PARTS IDENTIFICATION

6-8. A thorough breakdown of mechanical and electro-mechanical components is provided in Section VII. These illustrations are useful for parts identification and assembly/disassembly information.

### 6-9. ORDERING INFORMATION

6-10. Order all replacement parts from your local Hewlett-Packard Sales/Service Office (see addresses in back of this manual). The order should include part number and description from this section. If the required part is not listed in this section provide model and serial numbers of the instrument. Describe the part including function and location.

MODEL 680 GENERAL WIRING (Refer to Schematic C-15457)

| Circuit Symbol | Model Used On  | Hewlett-Packard Part No.                      | Description   | Typical Mfr.  | Mfrs. Part No.                                  |
|----------------|--|---|---|---|---|
| B300           | All except 681, 682, 683<br>681, 682, 683<br>Option 10 | M18424<br><br>(see figure 6-4)<br>17999-19649 | Chart Motor, 60 Hz<br><br>Chart Motor, 50 and 60 Hz<br><br>Chart Motor, 50 Hz | Hewlett-Packard<br><br>Hewlett-Packard<br><br>Hewlett-Packard | M18424<br><br>See figure 6-4<br><br>17999-19649 |
| B301           | All  | A10822  | Motor-servo   | Hewlett-Packard   | A10822  |
| C101           | All except 682<br><br>682                              | 0160-0819<br><br>NOT USED                     | Capacitor, Metal, 0.05 uf, 600v   | Cornell-Dubilier  | WMF-6S5   |

FIGURE 6-1. PARTS LIST (Sheet 1 of 11)

| Circuit Symbol | Model Used On  | Hewlett-Packard Part No. | Description                      | Typical Mfr. | Mfrs. Part No.  |
|----------------|--|--------------------------|----------------------------------|--------------|-----------------|
| C102           | All except H02-680, 682<br>Option 17 and H02-680 682 | 0180-0100                | Capacitor, Tant, 4.7 uf, 35v     | Sprague      | 150D475X90350-3 |
|                |  | 0180-0195                | Capacitor, Tant, 0.33 uf, 35v    | Sprague      | 150D334X00312   |
|                |  | NOT USED                 |                                  |              |                 |
| C103           | All except H02-680, 682<br>H02-680 and Option 17 682 | 0180-0100                | Capacitor, Tant, 4.7 uf, 35v     | Sprague      | 150D475X90350-3 |
|                |  | 0180-0195                | Capacitor, Tant, 0.33 uf, 35v    | Sprague      | 150D334X00312   |
|                |  | NOT USED                 |                                  |              |                 |
| C104           | All except H02-680, 682<br>H02-680 and Option 17 682 | 0180-0100                | Capacitor, Tant, 4.7 uf, 35v     | Sprague      | 150D475X90350-3 |
|                |  | 0180-0195                | Capacitor, Tant, 0.33 uf, 35v    | Sprague      | 150D334X00312   |
|                |  | NOT USED                 |                                  |              |                 |
| C105           | 680, 681, 683  | 0160-2066                | Capacitor, Metal, 0.022 uf, 200v | Electro Cube | Type 210B       |
|                | H01-680  | 0160-2088                | Capacitor, Metal, 0.025 uf, 200v | Electro Cube | ECI-210B        |
|                | H02-680  | 0160-2067                | Capacitor, Metal, 0.018 uf, 200v | Electro Cube | Type 210B       |
|                | Option 17  | 0160-2031                | Capacitor, mica, 0.0036 uf, 500v |              |                 |
|                | 682  | NOT USED                 |                                  |              |                 |
| C200           | All  | 0180-0324                | Capacitor, Elect, 6 uf, 15v      | Sprague      | 30D605G015BA4   |
| C201           | All  | 0180-0324                | Capacitor, Elect, 6 uf, 15v      | Sprague      | 30D605G015BA4   |
| C202           | All  | 0160-0157                | Capacitor, Metal, 0.0047 uf 200v | Faradyne     | MFD472K         |
| C203           | All except H02-680<br>H02-680 and Option 17          | 0180-0320                | Capacitor, Elect, 10 uf, 6v      | Sprague      | TE-1087         |
|                |  | 0180-0298                | Capacitor, Elect, 25 uf, 3v      | Sprague      |                 |
| C204           | All except H02-680<br>H02-680 and Option 17          | 0160-0194                | Capacitor, Metal, 0.015 uf, 200v | Faradyne     | MFC153M         |
|                |  | 0160-2075                | Capacitor, Metal, 0.047 uf, 100v | CD           | SMF1547E        |
| C205           | All except H02-680<br>H02-680 and Option 17          | NOT USED                 |                                  |              |                 |
| C206           | All except H02-680<br>H02-680 and Option 17          | 0180-0297                | Capacitor, Elect, 4 uf, 12v      | Sprague      | 30D405G012AA4   |
|                |  | NOT USED                 |                                  |              |                 |
| C207           | All except H02-680<br>H02-680 and Option 17          | 0180-0298                | Capacitor, Elect, 25 uf, 3v      | Sprague      | 30D256G-003BA4  |
|                |  | NOT USED                 |                                  |              |                 |
| C208           | All except H02-680<br>H02-680 and Option 17          | 0180-0320                | Capacitor, Elect, 10 uf, 6v      | Sprague      | TE-1087         |
|                |  | 0180-0303                | Capacitor, Elect, 100 uf, 3v     | Sprague      | TE-1059-5       |
|                |  | 0180-0298                | Capacitor, Elect, 25 uf, 3v      | Sprague      | 30D256G003BA4   |

FIGURE 6-1. PARTS LIST (Sheet 2 of 11)



| Circuit Symbol | Model Used On                               | Hewlett-Packard Part No. | Description   | Typical Mfr.       | Mfrs. Part No.           |
|----------------|---|--------------------------|---|--------------------|--------------------------|
| C209           | All except H02-680<br>H02-680 and Option 17 | NOT<br>0180-0039         | USED<br>Capacitor, Elect, 100 uf, 12v                       | Sprague            | 30D107G012DC4            |
| C210           | All except H02-680<br>H02-680 and Option 17 | 0180-0341<br>0180-0324   | Capacitor, Elect, 25 uf, 10v<br>Capacitor, Elect, 6 uf, 15v | Sprague<br>Sprague | TE-1118<br>30D605G015BA4 |
| C211           | All   | 0180-0320                | Capacitor, Elect, 10 uf, 6v                                 | Sprague            | TE-1087                  |
| C212           | All   | 0180-0342                | Capacitor, Elect, 250 uf, 6v                                | Sprague            | TE-1105                  |
| C213           | All   | 0180-0039                | Capacitor, Elect, 100 uf, 12v                               | Sprague            | TE-1135                  |
| C214           | All   | 0180-0320                | Capacitor, Elect, 10 uf, 6v                                 | Sprague            | TE-1087                  |
| C215           | All   | 0180-0303                | Capacitor, Elect, 100 uf, 3v                                | Sprague            | TE-1059-5                |
| C216           | All   | 0180-0320                | Capacitor, Elect, 10 uf, 6v                                 | Sprague            | TE-1087                  |
| C217           | All   | 0160-0194                | Capacitor, Metal, 0.015 uf, 200v                            | Faradyne           | MFC153M                  |
| C218           | All   | 0180-0340                | Capacitor, Elect, 6 uf, 12v                                 | Sprague            | TE-1127                  |
| C301           | All except 682, 683, 682, 683               | 0150-0119<br>NOT USED    | Capacitor, dual, (2) 0.1 uf, 250v, 2%                       | Sprague            | 36C219A                  |
| C302           | All   | 0180-0141                | Capacitor, Elect, 50 uf, 50v                                | Sprague            | TE-1307                  |
| C303           | All   | 0180-0094                | Capacitor, Elect, 100 uf, 25v                               | Sprague            | TE-1211                  |
| C304           | All   | FACTORY                  | SELECTED CAPACITOR  |                    |                          |
| C400           | Option 15                                   | 0180-1739                | Capacitor, fxd alum, elec, 250 uf, +75 -10%                 | Sprague            | 390257-G050HE4           |
| CR200          | All except H02-680<br>H02-680 and Option 17 | NOT<br>1902-0057         | USED<br>Diode, Zener  | Hoffman            | Z3444                    |
| CR201          | All   | 1910-0016                | Diode   | Transitron         | T12G                     |
| CR202          | All   | 1901-0022                | Diode   | Hewlett-Packard    | 1901-0022                |
| CR203          | All   | 1902-0768                | Diode, Zener  |                    | PSI10074                 |
| CR204          | All   | 1901-0157                | Diode   | Solitron           | HC-30                    |
| CR205          | All   | 1901-0157                | Diode   | Solitron           | HC-30                    |
| CR206          | All   | 1901-0157                | Diode   | Solitron           | HC-30                    |
| CR207          | All   | 1901-0157                | Diode   | Solitron           | HC-30                    |
| CR300          | All   | 1901-0158                | Diode   | Diodes, Inc        | SD-2                     |
| CR301          | All   | 1901-0158                | Diode (Optional)  | Diodes, Inc        | SD-2                     |
| CR302          | All   | 1901-0157                | Diode   | Solitron           | HC-30                    |
| CR303          | All   | 1901-0158                | Diode   | Diodes, Inc        | SD-2                     |
| CR304          | All   | 1901-0158                | Diode   | Diodes, Inc        | SD-2                     |
| CR305          | All   | 1901-0158                | Diode   | Diodes, Inc        | SD-2                     |
| CR306          | All   | 1901-0158                | Diode   | Diodes, Inc        | SD-2                     |
| CR307          | All   | 1910-0016                | Diode   | Hewlett-Packard    | 1910-0016                |
| CR308          | All   | 1910-0016                | Diode   | Hewlett-Packard    | 1910-0016                |
| CR309          | All   | 1902-0774                | Diode, Zener  | Int. Rec.          | 1N1513                   |
| CR310          | All   | 1902-0774                | Diode, Zener, 12.1v   | Int. Rec.          | 1N1513                   |

FIGURE 6-1. PARTS LIST (Sheet 3 of 11)

| Circuit Symbol | Model Used On         | Hewlett-Packard Part No. | Description                   | Typical Mfr.    | Mfrs. Part No. |
|----------------|-----------------------|--------------------------|-------------------------------|-----------------|----------------|
| CR311          | All except 682        | 1902-0761                | Diode, Zener                  | U. S. Semcor    | IN429(or821)   |
| CR400          | Option 15             | 1901-0191                | Diode                         | Motorola        | SR1358-2       |
| CR401          | Option 15             | 1901-0191                | Diode                         | Motorola        | SR1358-2       |
| CR402          | Option 15             | 1902-0670                | Diode                         | Motorola        |                |
| CR403          | Option 15             | 1902-0022                | Diode                         | Motorola        | SZ10939-16     |
| CR404          | Option 15             | 1902-0022                | Diode                         | Motorola        | SZ10939-16     |
| DS100          | Option 17             | 17999-19017              | Light Block Assy              | Hewlett-Packard | 17999-19017    |
| F300           | All                   | 2110-0018                | Fuse, 1/4 amp                 |                 | 3AG SB         |
|                |                       | 2110-0064                | Fuse, 1/8 amp                 |                 | 3AG SB         |
| G200           | All                   | 1130-0002                | Chopper                       | Airpax          | Mod. 33        |
| J100           | All except 682        | 1251-1186                | Connector, Input              |                 |                |
| J101           | All except 682        | 1510-0008                | Connector, Input (Red)        | Hewlett-Packard | 1510-0008      |
| J102           | All except 682        | 1510-0009                | Connector, Input (Black)      | Hewlett-Packard | 1510-0009      |
| J103           | All except 682        | 1510-0009                | Connector, Input (Black)      | Hewlett-Packard | 1510-0009      |
| J104           | All                   | 1251-1014                | Connector                     | Winchester      | JF1P-35        |
| J105           | Option 17             | 1251-1113                | Connector                     | Winchester      | JF1P-1S        |
| J200           | All                   | 1251-0166                | Connector                     | Amphenol        | 143-010-08     |
| J300           | All                   | 1251-0406                | Jack, remote pen              | Tini Jax        | #41            |
| J301           | All                   | 1251-0406                | Jack, event marker (optional) | Tini Jax        | 41             |
| J302           | All                   | 1251-1113                | Connector                     | Winchester      | JF1P-1S        |
| J303           | All                   | 8120-0078                | Power Cord                    | Beldon          | PH 151         |
| J304           | Option 09 All         | 1251-0406                | Jack, Remote Chart Advance    | Tini Jax        | #41            |
| J305           | All                   | 1251-0476                | Connector                     | Amphenol        | 143-012        |
| J306           | All                   | 1251-1113                | Connector                     | Winchester      |                |
| J400           | Option 15             | 1251-0166                | Connector                     |                 |                |
| J401           | Option 15             | 1251-1317                | Connector                     | Winchester      | JF1P-3S        |
| K300           | All                   | A11843                   | Coil-pen lift                 | Hewlett-Packard | A11843         |
| K301           | Optional All          | A12251                   | Coil-event marker             | Hewlett-Packard | A12251         |
| P100           | All except 682        | NOT USED                 | P. C. BOARD                   |                 |                |
| P104           | All                   | 1251-1015                | Connector                     | Winchester      | JF3P-1S        |
| P105           | Option 17             | 1251-1113                | Connector                     | Winchester      | JF1P-1S        |
| P200           | All                   | PART OF                  | P. C. BOARD                   |                 |                |
| P302           | All                   | 1251-1113                | Connector                     | Winchester      | JF1P-1S        |
| P303           | All                   | 1251-0148                | Receptacle, Power             | Tower           | H1061-1G       |
| P305           | All                   | 1251-1113                | Connector                     | Winchester      | JF1P-1S        |
| P400           | Option 15             | PART OF                  | P. C. BOARD                   |                 |                |
| P401           | Option 15             | 1251-1015                | Connector                     | Winchester      | JF1P-1S        |
| Q200           | All except H02-680    | NOT USED                 |                               |                 |                |
|                | H02-680 and Option 17 | 1850-0062                | Transistor                    | RCA             | 2N404          |

FIGURE 6-1. PARTS LIST (Sheet 4 of 11)

| Circuit Symbol | Model Used On                               | Hewlett-Packard Part No. | Description  | Typical Mfr.     | Mfrs. Part No.   |
|----------------|---|--------------------------|--|------------------|------------------|
| Q201           | All except H02-680<br>H02-680 and Option 17 | 1850-0154                | Transistor   | GE               | 2N508A           |
|                |   | 1850-0062                | Transistor   | RCA              | 2N404            |
| Q202           | All   | 1850-0154                | Transistor   | GE               | 2N508A           |
| Q203           | All   | 1850-0156                | Transistor   | Motorola         | 2N1370           |
| Q204           | All   | 1850-0156                | Transistor   | Motorola         | 2N1370           |
| Q205           | All   | 1854-0071                | Transistor   | Motorola         | 2N3391           |
| Q206           | All   | 1850-0076                | Transistor   | TI               | 2N1038-2         |
| Q300           | All   | 1850-0157                | Transistor   | Hewlett-Packard  | 1850-0157        |
| Q400           | Option 15                                   | 1854-0300                | Transistor   | Motorola         | MJE 521          |
| Q401           | Option 15                                   | 1853-0073                | Transistor   | Motorola         | MJE 371          |
| Q402           | Option 15                                   | 1853-0073                | Transistor   | Motorola         | MJE 371          |
| R100           | 680, 681, 682, 683<br>H01-680               | NOT USED<br>0811-0440    | Resistor, Prec, ww, 800 $\Omega$ ,<br>0.1%                               | Cinema           | CE543E           |
|                | H02-680                                     | 0811-0457                | Resistor, Prec, ww, 50K,<br>0.1%   | Cinema           | CD542E           |
| R101           | 680 and H01-680                             | 0811-1233                | Resistor, Prec, ww, 1K,<br>0.1%  | Cinema           | CE542E           |
|                | H02-680                                     | 0811-0378                | Resistor, Prec, ww, 40K,<br>0.1%   | Cinema           | CE542E           |
|                | 681, 682, 683                               | NOT USED                 |  |                  |                  |
| R102           | 680 and H01-680<br>H02-680                  | 0811-1517<br>0811-0445   | Resistor, Prec, 8K, 0.1%<br>Resistor, Prec, ww, 5K,<br>0.1%              | Cinema<br>Cinema | CE542E<br>CE542E |
|                | 681, 682, 683                               | NOT USED                 |  |                  |                  |
|                |   |                          |  |                  |                  |
| R103           | 680 and H01-680<br>H02-680                  | 0811-0919<br>0811-0377   | Resistor, Prec, 10K, 0.1%<br>Resistor, Prec, ww, 4K,<br>0.1%             | Cinema<br>Cinema | CE542E<br>CE542E |
|                | 681, 682, 683                               | NOT USED                 |  |                  |                  |
|                |   |                          |  |                  |                  |
| R104           | 680 and H01-680<br>H02-680                  | 0811-0459<br>0811-0438   | Resistor, Prec, 80K, 0.1%<br>Resistor, Prec, ww, 500 $\Omega$ ,<br>0.1%  | Cinema<br>Cinema | CE542E<br>CE542E |
|                | 681, 682, 683                               | NOT USED                 |  |                  |                  |
|                |   |                          |  |                  |                  |
| R105           | 680 and H01-680<br>H02-680                  | 0811-0460<br>0811-0436   | Resistor, Prec, 100K, 0.1%<br>Resistor, Prec, ww, 400 $\Omega$ ,<br>0.1% | Cinema<br>Cinema | CE542E<br>CE542E |
|                | 681, 682, 683                               | NOT USED                 |  |                  |                  |
|                |   |                          |  |                  |                  |
| R106           | 680   | 0811-1249                | Resistor, Prec, 800K, 0.1%   | Cinema           | CE543E           |
|                | H01-680                                     | 0811-0473                | Resistor, Prec, ww, 1 meg,<br>0.1%                                       | Cinema           | CE542E           |
|                | H02-680                                     | 0811-0422                | Resistor, Prec, ww, 50 $\Omega$ ,<br>0.1%                                | Cinema           | CE542E           |
|                | 681, 682, 683                               | NOT USED                 |  |                  |                  |

FIGURE 6-1. PARTS LIST (Sheet 5 of 11)

| Circuit Symbol | Model Used On      | Hewlett-Packard Part No. | Description                               | Typical Mfr.  | Mfrs. Part No. |
|----------------|--------------------|--------------------------|---|---------------|----------------|
| R107           | 680                | 0811-0473                | Resistor, Prec, ww, 1 meg, 0.1%           | Cinema        | CE411E         |
|                | H01-680            | 0811-0422                | Resistor, Prec, ww, 50 $\Omega$ , 0.1%    | Cinema        | CE542E         |
|                | H02-680            | 0811-0436                | Resistor, Prec, ww, 40 $\Omega$ , 0.1%    | Cinema        | CE542E         |
|                | 681, 682, 683      | NOT USED                 |   |               |                |
| R108           | 680                | 0811-0433                | Resistor, Prec, 249.89 $\Omega$ , 0.1%    | Cinema        | CE542E         |
|                | H01-680            | 0811-0419                | Resistor, Prec, ww, 22.22 $\Omega$ , 0.1% | Cinema        | CE542E         |
|                | H02-680            | 0811-0417                | Resistor, Prec, ww, 5 $\Omega$ , 0.1%     | Cinema        | CE542E         |
|                | 681, 682, 683      | NOT USED                 |   |               |                |
| R109           | 680                | 0811-0429                | Resistor, Prec, 11.06 $\Omega$ , 0.1%     | Cinema        | CE542E         |
|                | H01-680, 682, 683  | NOT USED                 |   |               |                |
|                | H02-680            | 0811-0417                | Resistor, Prec, ww, 5 $\Omega$ , 0.1%     | Cinema        | CE542E         |
|                | 681                | SEE FIGURE 6-3           |   |               |                |
| R110           | 680, H01-680       | 0683-3615                | Resistor, Comp, 360 $\Omega$ , 1/4w, 5%   | Allen-Bradley |                |
|                | 681, 683           |                          |   |               |                |
|                | H02-680            | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%            | Allen-Bradley |                |
|                | 682                | NOT USED                 |   |               |                |
| R111           | 680                | 0811-1233                | Resistor, Prec, 1K, 0.1%                  | Cinema        | CE542E         |
|                | H01-680            | 0811-0432                | Resistor, Prec, ww, 200 $\Omega$ , 0.1%   | Cinema        | CE542E         |
|                | H02-680            | 0684-1531                | Resistor, Comp, 15K, 1/4w, 10%            | Allen-Bradley |                |
|                | 681                | SEE FIGURE 6-3           |   |               |                |
|                | 682                | NOT USED                 |   |               |                |
|                | 683                | FACTORY SELECTED         |   |               |                |
| R112           | All except H02-680 | NOT USED                 |   |               |                |
|                | H02-680            | 0683-1835                | Resistor, Comp, 18K, 1/4w, 5%             | Allen-Bradley |                |
| R113           | All except H02-680 | NOT USED                 |   |               |                |
|                | H02-680            | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%            | Allen-Bradley |                |
| R114           | All except H02-680 | NOT USED                 |   |               |                |
|                | H02-680            | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%            | Allen-Bradley |                |
| R115           | All except H02-680 | NOT USED                 |   |               |                |
|                | H02-680            | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%            | Allen-Bradley |                |
| R116           | All except H02-680 | NOT USED                 |   |               |                |
|                | H02-680            | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%            | Allen-Bradley |                |
| R117           | All except H02-680 | NOT USED                 |   |               |                |
|                | H02-680            | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%            | Allen-Bradley |                |

FIGURE 6 1. PARTS LIST (Sheet 6 of 11)

| Circuit Symbol | Model Used On   | Hewlett-Packard Part No.   | Description  | Typical Mfr.   | Mfrs. Part No.                                      |
|----------------|---|--|--|--|---|
| R118           | All except H02-680<br>H02-680   | NOT<br>0684-2231   | USED<br>Resistor, Comp, 22K, 1/4w, 10%   | Allen-Bradley  |   |
| R119           | 680 except metric<br>680M<br>H01-680 except metric<br>H01-680M<br>H02-680 except metric and 683<br>H02-680M<br>681<br>682           | 0757-0415<br>0684-5611<br>0757-0401<br>0811-1329<br>0757-0415<br>0698-3253<br>SEE<br>NOT | Resistor, Carbon, 475 $\Omega$ , 1/8w, 1%<br>Resistor, Comp, 560 $\Omega$ , 1/4w, 5%<br>Resistor, Carbon, 100 $\Omega$ , 1%<br>Resistor, Prec, ww, 120 $\Omega$ , 1%<br>Resistor, Carbon, 475 $\Omega$ , 1/8w, 1%<br>Resistor, Carbon, 560 $\Omega$ , 1/8w, 1%<br>FIGURE 6-3<br>USED | Electra<br>Allen-Bradley<br>Allen-Bradley<br>Allen-Bradley<br>Electra<br>Electra | MF5CD4750F<br><br><br><br>MF5CD4750F<br>MF5C-CB481C |
| R120           | All except 682<br>682   | 0757-0481<br>NOT   | Resistor, Carbon, 475K, 1/8w, 1%<br>USED   | Electra  | MF5CD4753F  |
| R121           | All except 682<br>682   | 2100-0407<br>NOT   | Resistor, Var, 5K, $\pm 10\%$<br>USED  | CT   | Type 252  |
| R122           | 680, 681, 683,<br>H01-680<br>H02-680 and<br>Option 17<br>682  | 0683-3615<br>0684-1021<br>NOT  | Resistor, Comp, 360 $\Omega$ , 1/4w, 5%<br>Resistor, Prec, 1K, 1/4w, 10%<br>USED   | Allen-Bradley<br>Allen-Bradley   |   |
| R123           | 680, 681, 683<br>H01-680<br>H02-680 and<br>Option 17<br>682   | 0683-3615<br>0684-1021<br>NOT  | Resistor, Comp, 360 $\Omega$ , 1/4w, 5%<br>Resistor, Prec, 1K, 1/4w, 10%<br>USED   | Allen-Bradley<br>Allen-Bradley   |   |
| R124           | 680 except metric<br>Option 17<br>H01-680 except metric<br>H01-680M<br>H02-680 except metric and 683<br>680M H02-680M<br>681<br>682 | 0811-0994<br>0811-1293<br>0811-0432<br>0811-0479<br>0811-0994<br>0811-0483<br>SEE<br>NOT | Resistor, Prec, ww, 1K, 1%<br>Resistor, Prec, ww, 5K, 0.1%<br>Resistor, Prec, ww, 200 $\Omega$ , 0.1%<br>Resistor, Prec, ww, 250 $\Omega$ , 1%<br>Resistor, Prec, ww, 1K, 1%<br>Resistor, Prec, ww, 1.2K, 1%<br>FIGURE 6-3<br>USED   | Cinema<br>Kelvin<br>Cinema<br>Cinema<br>Cinema<br>Cinema                         | B11E<br>KP101<br>CE542E<br>CE542E<br>B11E<br>CE542E |
| R125           | All except 682<br>and Option 17<br>682<br>Option 17   | 0698-3267<br>NOT<br>0698-3587  | Resistor, Carbon, 750K, 1/2w, 1%<br>USED<br>Resistor, Carbon, 5 meg, 1/2%  | Electra<br>Electra   | MF7C-E-7503F<br>MF5C-D-4753                         |

FIGURE 6-1. PARTS LIST (Sheet 7 of 11)

| Circuit Symbol | Model Used On   | Hewlett-Packard Part No.      | Description  | Typical Mfr.                       | Mfrs. Part No.   |
|----------------|---|-------------------------------|--|------------------------------------|------------------|
| R126           | All except H02-680<br>H02-680   | NOT<br>0684-1041              | USED<br>Resistor, Comp, 100K, 1/4w, 10%                                | Allen-Bradley                      |                  |
| R127           | All models except metric and 682<br>All metric models except 682<br>Option 17 and 682 | 0811-0484<br>0811-0376<br>NOT | Resistor, Prec, ww, 1.5K, 0.1%<br>Resistor, Prec, ww, 2.5K, 1%<br>USED | Cinema<br>Cinema                   | CE542E<br>CE542E |
| R128           | All except 682  | 2100-1416<br>NOT              | Resistor, Var, 1K, ±20%<br>USED  | CT                                 | BK12449          |
| R129           | All except Option 17<br>Option 17   | M10082<br>17999-19063         | Resistor, slidewire, 5K<br>Photo Slidewire Assy                        | Hewlett-Packard<br>Hewlett-Packard |                  |
| R130           | Option 17   | 0811-2147                     | Resistor, Fxd, 70 Ω, 1w  | Allen-Bradley                      |                  |
| R200           | All   | 0686-4315                     | Resistor, Comp, 430 Ω, 1/2w, 5%  | Allen-Bradley                      |                  |
| R201           | All except H02-680<br>H02-680 and Option 17   | 0683-2435<br>0683-1025        | Resistor, Comp, 24K, 1/4w, 5%<br>Resistor, Comp, 1K, 1/4w, 5%          | Allen-Bradley<br>Allen-Bradley     |                  |
| R202           | All except H02-680<br>H02-680 and Option 17   | NOT<br>0684-2731              | USED<br>Resistor, Comp, 27K, 1/4w, 10%                                 | Allen-Bradley                      |                  |
| R203           | All except H02-680<br>H02-680 and Option 17   | NOT<br>0683-1025              | USED<br>Resistor, Comp, 1K, 1/4w, 5%                                   | Allen-Bradley                      |                  |
| R204           | All except H02-680<br>H02-680 and Option 17   | NOT<br>0684-3921              | USED<br>Resistor, Comp, 3.9K, 1/4w, 10%                                | Allen-Bradley                      |                  |
| R205           | All except H02-680<br>H02-680 and Option 17   | NOT<br>0684-8231              | USED<br>Resistor, Comp, 82K, 1/4w, 10%                                 | Allen-Bradley                      |                  |
| R206           | All   | 0684-2731                     | Resistor, Comp, 27K, 1/4w, 10%   | Allen-Bradley                      |                  |
| R207           | All except H02-680<br>H02-680 and Option 17   | NOT<br>0683-6225              | USED<br>Resistor, Comp, 6.2K, 1/4w, 5%                                 | Allen-Bradley                      |                  |
| R208           | All except H02-680<br>H02-680 and Option 17   | NOT<br>0684-1011              | USED<br>Resistor, Comp, 100 Ω, 1/4w, 10%                               | Allen-Bradley                      |                  |
| R209           | All except H02-680<br>H02-680 and Option 17   | 0684-4721<br>0683-1135        | Resistor, Comp, 4.7K, 1/4w, 10%<br>Resistor, Comp, 11K, 1/4w, 5%       | Allen-Bradley<br>Allen-Bradley     |                  |
| R210           | All except H02-680<br>H02-680 and Option 17   | NOT<br>0683-1025              | USED<br>Resistor, Comp, 1K, 1/4w, 5%                                   | Allen-Bradley                      |                  |

FIGURE 6-1. PARTS LIST (Sheet 8 of 11)

| Circuit Symbol | Model Used On                               | Hewlett-Packard Part No. | Description                              | Typical Mfr.  | Mfrs. Part No. |
|----------------|---|--------------------------|--|---------------|----------------|
| R211           | All except H02-680                          | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%           | Allen-Bradley | UPE-70         |
|                | H02-680 and Option 17                       | 0683-2035                | Resistor, Comp, 20K, 1/4w, 5%            | Allen-Bradley |                |
| R212           | All except H02-680<br>H02-680 and Option 17 | NOT USED<br>0684-1231    | Resistor, Comp, 12K, 1/4w, 10%           | Allen-Bradley |                |
| R213           | All   | 0684-4721                | Resistor, Comp, 4.7K, 1/4w, 10%          | Allen-Bradley |                |
| R214           | All except H02-680                          | 0684-0145                | Resistor, Comp, 1K, 1/4w, 10%            | Allen-Bradley |                |
|                | H02-680 and Option 17                       | 0684-4711                | Resistor, Comp, 470 $\Omega$ , 1/4w, 10% | Allen-Bradley |                |
| R215           | All   | 0684-8221                | Resistor, Comp, 8.2K, 1/4w, 10%          | Allen-Bradley |                |
| R216           | All   | 0683-6235                | Resistor, Comp, 62K, 1/4w, 10%           | Allen-Bradley |                |
| R217           | All   | 0684-1011                | Resistor, Comp, 100 $\Omega$ , 1/4w, 10% | Allen-Bradley |                |
| R218           | All   | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%           | Allen-Bradley |                |
| R219           | All   | 0684-5621                | Resistor, Comp, 5.6K, 1/4w, 10%          | Allen-Bradley |                |
| R220           | All   | 0684-5621                | Resistor, Comp, 5.6K, 1/4w, 10%          | Allen-Bradley |                |
| R221           | All   | 0684-1521                | Resistor, Comp, 1.5K, 1/4w, 10%          | Allen-Bradley |                |
| R222           | All   | 0684-2231                | Resistor, Comp, 22K, 1/4w, 10%           | Allen-Bradley |                |
| R223           | All   | 2100-0093                | Resistor, Var, 20K, 1/4w, 30%            | CTS           |                |
| R224           | All   | 0683-6235                | Resistor, Comp, 62K, 1/4w, 10%           | Allen-Bradley |                |
| R225           | All   | 0684-2221                | Resistor, Comp, 2.2K, 1/4w, 10%          | Allen-Bradley |                |
| R226           | All   | 0684-2221                | Resistor, Comp, 2.2K, 1/4w, 10%          | Allen-Bradley |                |
| R227           | All   | 0684-6801                | Resistor, Comp, 68 $\Omega$ , 1/4w, 10%  | Allen-Bradley |                |
| R228           | All   | 0683-1135                | Resistor, Comp, 11K, 1/4w, 5%            | Allen-Bradley |                |
| R229           | All   | 0683-1025                | Resistor, Comp, 1K, 1/4w, 5%             | Allen-Bradley |                |
| R230           | All   | 0684-2201                | Resistor, Comp, 22 $\Omega$ , 1/4w, 10%  | Allen-Bradley |                |
| R231           | All   | 0684-1031                | Resistor, Comp, 10K, 1/4w, 10%           | Allen-Bradley |                |
| R232           | All   | 0684-6801                | Resistor, Comp, 68 $\Omega$ , 1/4w, 10%  | Allen-Bradley |                |

FIGURE 6-1. PARTS LIST (Sheet 9 of 11)

| Circuit Symbol | Model Used On   | Hewlett-Packard Part No.                  | Description  | Typical Mfr.                                    | Mfrs. Part No.   |
|----------------|---|---|--|---|------------------|
| R300           | All   | 0813-0050                                 | Resistor, Non-prec, ww, 100 $\Omega$ , 3w  | Sprague   | 242E-1015        |
| R301           | All   | 0813-0050                                 | Resistor, Non-prec, ww, 100 $\Omega$ , 3w  | Sprague   | 242E-1015        |
| R302           | All   | 0684-2721                                 | Resistor, Comp, 2.7K, 1/4w, 10%  | Allen-Bradley                                   |                  |
| R303           | All   | 0684-2211                                 | Resistor, Comp, 220 $\Omega$ , 1/4w, 10%   | Allen-Bradley                                   |                  |
| R304           | All   | 0684-1821                                 | Resistor, Comp, 1.8K, 1/4w, 10%  | Allen-Bradley                                   |                  |
| R305           | All   | 0684-2211                                 | Resistor, Comp, 220 $\Omega$ , 1/4w, 10%   | Allen-Bradley                                   |                  |
| R306           | All except 682  | 0684-4711                                 | Resistor, Comp, 470 $\Omega$ , 1/4w, 10%   | Allen-Bradley                                   |                  |
| R400           | Option 15   | NOT USED<br>0686-8215                     | Resistor, fxd, comp, 820 $\Omega$ , 1/2w, 5%   | Allen-Bradley                                   |                  |
| R401           | Option 15   | 0686-2405                                 | Resistor, Comp, 24 $\Omega$ , 5%, 1/2w   | Allen-Bradley                                   |                  |
| R402           | Option 15   | 0812-0043                                 | Resistor, fxd, 100 $\Omega$ , 1w, $\pm 3\%$  |   |                  |
| R403           | Option 15   | 0811-2469                                 | Resistor, fxd, 1.2K, 1w, 1%  | Dale  | RS1A             |
| R404           | Option 15   | 0686-4705                                 | Resistor, Comp, 47 $\Omega$ , 1/4w, 5%   | Allen-Bradley                                   |                  |
| R405           | Option 15   | 0813-0050                                 | Resistor, fxd, ww, 100 $\Omega$ , 3w, 5%   | Sprague   | 242E             |
| R406           | Option 15   | 0811-2469                                 | Resistor, fxd, 1.2K, 1w, 1%  | Dale  | RS1A             |
| S101           | 680 and H01-680, H02-680<br>H01-680<br>680<br>681, 682, 683 | 3100-1574<br>M11872<br>M10074<br>NOT USED | Switch, Attenuator<br>Complete Atten. Switch Assy<br>Complete Atten. Switch Assy<br>NOT USED | Centralab<br>Hewlett-Packard<br>Hewlett-Packard | PA2000 SER       |
| S300           | All   | 3101-0158                                 | Switch, Interlock  | Switchcraft                                     |                  |
| S301           | All   | 3101-0062                                 | Switch, Pen lift   | Hetherington                                    | T-3103           |
| S302           | All   | 3101-0062                                 | Switch, Power  | Hetherington                                    | T-3103           |
| S303           | All   | 3101-0033                                 | Switch, Power conversion   | Hewlett-Packard                                 | 3101-0033        |
| T200           | All except H02-680<br>H02-680 and<br>Option 17              | 9100-1526<br>9100-1532                    | Transformer, Input<br>Transformer, Input   | McCarron<br>Triad                               | M2064<br>G-95052 |
| T300           | All   | 1850-0157                                 | Transformer, Power   | Ferrodyne                                       | 6028             |
| T400           | Option 15   | 9100-2431                                 | Transformer, Power   | Topaz   | 61128            |
| MISCELLANEOUS  |   |   |  |   |                  |
|                |   | A-11171                                   | Event Marker Coil (Up to S/N 360)  | Hewlett-Packard                                 |                  |
|                |   | A-12251                                   | Event Marker Coil (S/N 361 and Up)   | Hewlett-Packard                                 |                  |
|                |   | M-18688                                   | Event Marker Kit   | Hewlett-Packard                                 |                  |

FIGURE 6-1. PARTS LIST (Sheet 10 of 11)



| Circuit<br>Symbol | Model<br>Used On | Hewlett-<br>Packard<br>Part No. | Description                                      | Typical Mfr.    | Mfr. Part No.    |
|-------------------|------------------|---------------------------------|--|-----------------|------------------|
|                   |                  | A-12482                         | Pen Scale, Metric<br>(S/N 1976 and Up)           | Hewlett-Packard |                  |
|                   |                  | A-12482-F                       | Pen Scale, Metric<br>(Up to S/N 1976)            | Hewlett-Packard |                  |
|                   |                  | A-13002                         | Dual Rack Adapter with<br>Glass Door             | Hewlett-Packard |                  |
|                   |                  | A-15126                         | Pen Cleaning Wire                                | Hewlett-Packard |                  |
|                   |                  | A-15448                         | Dual Rack Adapter<br>(Open Type)                 | Hewlett-Packard |                  |
|                   |                  | B-9638                          | Pen Scale, Standard<br>(SN 1976 and UP)          | Hewlett-Packard |                  |
|                   |                  | B-9638-F                        | Pen Scale, Standard (Up to<br>(S/N 1976)         | Hewlett-Packard |                  |
|                   |                  | M-16897                         | Pressure Sensitive to Ink<br>(Conversion Kit)    | Hewlett-Packard |                  |
|                   |                  | M-18547                         | Accessory Kit (Ink)                              | Hewlett-Packard |                  |
|                   |                  | A-18371                         | Stylus (Pressure Sensitive)                      | Hewlett-Packard |                  |
|                   |                  | CHART PAPER AND INK SUPPLIES    |  |                 |                  |
|                   |                  | 9270-1012                       | Standard Roll Chart Paper                        | Hewlett-Packard |                  |
|                   |                  | 9270-1018                       | Hour Markings Every 4"                           | Hewlett-Packard |                  |
|                   |                  | 9270-1074                       | Electo Sensitive Paper                           | Hewlett-Packard |                  |
|                   |                  | 9270-1025                       | Matric Roll Chart Paper                          | Hewlett-Packard |                  |
|                   |                  | 9270-1033                       | Standard Pressure Sensitive<br>Paper (Red Trace) | Hewlett-Packard |                  |
|                   |                  | 9270-1045                       | Metric Pressure Sensitive<br>Paper (Red Trace)   | Hewlett-Packard |                  |
|                   |                  | 1530-0095                       | Ink Cartridge, Blue                              | Hewlett-Packard |                  |
|                   |                  | 1530-0703                       | Ink Cartridge, Red                               | Hewlett-Packard |                  |
|                   |                  | 1530-0704                       | Ink Cartridge, Green                             | Hewlett-Packard |                  |
|                   |                  | 1530-0984                       | Ink Cartridge, Purple                            | Hewlett-Packard |                  |
|                   |                  | 1530-0905                       | Ink Cartridge, Black                             | Hewlett-Packard |                  |
|                   |                  | 1530-0775                       | Spool, Paper                                     | Hewlett-Packard |                  |
|                   |                  | 0890-0349                       | Plastic Tubing<br>(From Primer)                  | Alphlex         | #PVC-105/5       |
|                   |                  | 0890-0351                       | Plastic Tubing (Ink Line)                        | Esterbrook      | Extra Flex Vinyl |

FIGURE 6-1. PARTS LIST (Sheet 11 of 11)

ONE YEAR ISOLATED SPARE PARTS

| Hewlett-Packard<br>Part No. | Description                                  | Mfr.<br>Designation       | RS       |
|-----------------------------|--|---------------------------|----------|
| A-9692                      | Spring, 60:1 lever                           | Hewlett-Packard           | 1        |
| A-10073                     | Gear Plate, With 2 to 1 reduction gears      | Hewlett-Packard           | 1        |
| A-10074                     | Attenuator Assembly                          | Hewlett-Packard           | 1        |
| M-18464                     | Pen Assembly                                 | Hewlett-Packard           | 2        |
| A-10082                     | Slidewire                                    | Hewlett-Packard           | 1        |
| A-10194                     | Spring, Pen holddown                         | Hewlett-Packard           | 2        |
| A-10351                     | Ring, Clutch pressure                        | Hewlett-Packard           | 1        |
| A-10534                     | Cartridge Holder                             | Hewlett-Packard           | 1        |
| A-10561                     | Spring, Tension (Fig. 4-6)                   | Hewlett-Packard           | 2        |
| A-10678                     | Spring, Nylon cord                           | Hewlett-Packard           | 2        |
| A-10822                     | Motor, DC servo                              | Hewlett-Packard           | 1        |
| A-10824                     | 60:1 Speed Changer (Epicyclic Gear Assembly) | Hewlett-Packard           | 1        |
| A-11641                     | Spring, Pen lift solenoid                    | Hewlett-Packard           | 2        |
| A-11843                     | Solenoid, Pen lift                           | Hewlett-Packard           | 1        |
| B-9572                      | Slider Block                                 | Hewlett-Packard           | 1        |
| B-9585                      | Wiper Contact                                | Hewlett-Packard           | 2        |
| M-10500                     | Lever, Gear shift                            | Hewlett-Packard           | 1        |
| 1850-0157                   | Transformer, Power                           | Ferodyne 6028             | 1        |
| 9100-1526                   | Transformer, Input                           | McCarron M2064            | 1        |
| 1530-0020                   | Chain, Chart magazine drive (0.123)          | Bohannon Industries       | 1 ft.    |
| 0900-0017                   | Ring, "O" chart magazine                     | Parker #2-9 (N219-7)      | 2        |
| 1530-0764                   | Chain, Beaded (105 beads) Type 3             | Voland & Sons             | 1        |
| 1530-0765                   | Chain, Beaded (110 beads) Type 3             | Voland & Sons             | 1        |
| 1130-0002                   | Chopper                                      | Airpax Mod. 33            | 1        |
| 8160-0050                   | Cord, Nylon Type 75                          | General Cement            | 3 ft.    |
| 3140-0060                   | Motor, Chart drive                           | Cramer Controls           | 1        |
| 9270-1012                   | Chart Paper                                  | Gubelman #GLR-12          | As Req'd |
| 2100-0407                   | Variable Resistor, 5K zero pot.              | CTC Spec 39346            | 2        |
| 1910-0016                   | Diode  | Transitron #T12G          | 2        |
| 1902-0761                   | Diode  | I. R. #31142              | 2        |
| 1901-0158                   | Diode  | Diodes, Inc. #SD-2        |          |
| 1850-0156                   | Transistor                                   | Motorola 2N1370           | 2        |
| 1851-0025                   | Transistor                                   | T.I. 2N1306               | 2        |
| 1850-0154                   | Transistor                                   | G. E. 2N508A              | 2        |
| 1854-0033                   | Transistor                                   | G. E. 2923                | 2        |
| 3101-0062                   | Switch, Power and pen lift                   | Hetherington T3103        | 1        |
| 8120-0078                   | Power Cord, 7.5 ft                           | Belden #PH151             | 1        |
| 2110-0018                   | Fuse, 1/4 amp, 115 v, 3 AG                   | Littlefuse                | 10       |
| 1530-0095                   | Ink Cartridge (Blue)                         | Esterbrook #40-8B         | As Req'd |
| 1530-0096                   | Primer Bulb                                  | Esterbrook #40-80-0611-11 | 2        |
| 1410-0276                   | Pulley, Return                               | Kilian #SR-180-6          | 2        |
| 0890-0349                   | Tubing, Plastic (primer line)                | Alphlex PVC-105/5         | 2 ft.    |
| 0890-0351                   | Tubing, Plastic (ink line)                   | Esterbrook - Vinyl        | 2 ft.    |
| 8500-0257                   | Slidewire Lubricant and Cleaner              | Hewlett-Packard           | 2        |

FIGURE 6-2. RECOMMENDED SPARE PARTS LIST (Sheet 1 of 2)

FOR 50 CYCLE OPERATION

| Hewlett-Packard Part No. | Description                         | Mfr. Designation          | RS    |
|--------------------------|-------------------------------------|---------------------------|-------|
| 3140-0213                | Chart Motor,                        | Cramer Controls           | 1     |
| 2110-0064                | Fuse, 1/8 amp, 115 v, 3 AG          | Littlefuse                | 10    |
| RUNNING SPARES           |                                     |                           |       |
| A-9692                   | Spring, 60:1 lever                  | Hewlett-Packard           | 1     |
| M18464                   | Pen Assembly                        | Hewlett-Packard           | 1     |
| M10082                   | Slidewire                           | Hewlett-Packard           | 1     |
| A-10194                  | Spring, Pen holddown                | Hewlett-Packard           | 1     |
| A-10561                  | Spring, Tension                     | Hewlett-Packard           | 1     |
| A-10678                  | Spring, Nylon cord                  | Hewlett-Packard           | 1     |
| A-10822                  | Motor, DC                           | Hewlett-Packard           | 1     |
| M18112                   | 60:1 Speed Changer (Epicyclic Gear) | Hewlett-Packard           | 1     |
| A-11641                  | Spring, Pen lift solenoid           | Hewlett-Packard           | 1     |
| A-11843                  | Solenoid, Pen lift                  | Hewlett-Packard           | 1     |
| B-9585                   | Wiper Contact                       | Hewlett-Packard           | 1     |
| 1130-0002                | Chopper 5080-7930                   | Airpax Mod. 33            | 1     |
| 8160-0050                | Cord, Nylon                         | General Cement            | 3 ft. |
| 2110-0018                | Fuse, 1/4 amp, 115 v, 3 AG          | Littlefuse                | 5     |
| 1530-0096                | Primer Bulb                         | Esterbrook #40-80-0611-11 | 1     |
| 0890-0349                | Tubing, Plastic                     | Alphlex PVC 105/5         | 1 ft. |
| 0890-0351                | Tubing, Plastic                     | Esterbrook Vinyl          | 1 ft. |
| 5080-3635                | Slidewire Lubricant                 | Hewlett-Packard           | 1     |
| 5080-3605                | Slidewire, Cleaner                  | Hewlett-Packard           | 1     |

FIGURE 6-2. RECOMMENDED SPARE PARTS LIST (Sheet 2 of 2)

| Circuit Symbol | Hewlett-Packard Part No. | Description                      | Typical Mfr.  | Mfrs. Part No. |
|----------------|--------------------------|----------------------------------|---------------|----------------|
| 5 MV RANGE     |                          |                                  |               |                |
| R-109          |                          | NOT USED                         |               |                |
| R-111          | 0811-0994                | Resistor, Prec, ww, 1K, 1%       | Cinema        | CE 542E        |
| R-119          | 0684-4711                | Resistor, Comp, 470Ω, 1/4 w, 10% | Allen-Bradley |                |
| R-124          | 0811-0994                | Resistor, Prec, ww, 1K, 1%       | Cinema        | CE 542E        |
| 10 MV RANGE    |                          |                                  |               |                |
| R-109          |                          | NOT USED                         |               |                |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%       | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%    | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K, 1%       | Cinema        | CE 542E        |

FIGURE 6-3. FACTORY SELECTED RESISTORS FOR VARIOUS RANGES IN 681/681M (Sheet 1 of 4)

| Circuit Symbol | Hewlett-Packard Part No. | Description                               | Typical Mfr.  | Mfrs. Part No. |
|----------------|--------------------------|---|---------------|----------------|
| 50 MV RANGE    |                          |   |               |                |
| R-109          | 0811-1265                | Resistor, Prec, ww, 8K, 1%                | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| 100 MV RANGE   |                          |   |               |                |
| R-109          | 0811-1266                | Resistor, Prec, ww, 18K, 1%               | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| 500 MV RANGE   |                          |   |               |                |
| R-109          | 0811-1267                | Resistor, Prec, ww, 98K, 1%               | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K                    | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| 1V RANGE       |                          |   |               |                |
| R-109          | 0811-1268                | Resistor, Prec, ww, 198K, 1%              | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| 5V RANGE       |                          |   |               |                |
| R-109          | 0757-0258                | Resistor, Carbon, 1M, 1%                  | Allen-Bradley |                |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| 10V RANGE      |                          |   |               |                |
| R-109          | 0698-3276                | Resistor, Carbon, 2 meg, 1%               | Allen-Bradley |                |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| 50V RANGE      |                          |   |               |                |
| R-109          | 0698-3276                | Resistor, Carbon, 2M $\Omega$ , 1%        | Allen-Bradley |                |
| R-111          | 0811-1270                | Resistor, Prec, ww, 400 $\Omega$ , 1%     | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K ohms, 1/4 w, 5%        | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K $\Omega$ , 1%      | Cinema        | CE 542E        |
| 100V RANGE     |                          |   |               |                |
| R-109          | 0698-3276                | Resistor, Carbon, 2 Meg, 1%               | Allen-Bradley |                |
| R-111          | 0811-0477                | Resistor, Prec, ww, 200 $\Omega$ , 1%     | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K $\Omega$ , 1/4 w, 5%   | Allen-Bradley |                |
| R-124          | 0811-1262                | Resistor, Prec, ww, 2K $\Omega$ , 1%      | Cinema        | CE 542E        |
| 1.2 MV RANGE   |                          |   |               |                |
| R-111          | 0811-0477                | Resistor, Prec, ww, 200 $\Omega$ , 1%     |               |                |
| R-119          | 0684-1011                | Resistor, Comp, 100 $\Omega$ , 1/4 w, 10% |               |                |
| R-124          | 0811-0477                | Resistor, Prec, ww, 200 $\Omega$ , 1%     |               |                |

FIGURE 6-3. FACTORY SELECTED RESISTORS FOR VARIOUS RANGES  
IN 681/681M (Sheet 2 of 4)

| Circuit Symbol | Hewlett-Packard Part No. | Description                               | Typical Mfr.  | Mfrs. Part No. |
|----------------|--------------------------|---|---------------|----------------|
|                |                          | 6MV RANGE                                 |               |                |
| R-109          |                          | NOT USED                                  |               |                |
| R-111          | 0811-0994                | Resistor, Prec, ww, 1K, 1%                | Cinema        | CE 542E        |
| R-119          | 0684-4711                | Resistor, Comp, 470 $\Omega$ , 1/4 w, 10% | Allen-Bradley |                |
| R-124          | 0811-0994                | Resistor, Prec, ww, 1K, 1%                | Cinema        | CE 542E        |
|                |                          | 12 MV RANGE                               |               |                |
| R-109          |                          | NOT USED                                  |               |                |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%              | Cinema        | CE 542E        |
|                |                          | 60 MV RANGE                               |               |                |
| R-109          | 0811-1265                | Resistor, Prec, ww, 8K, 1%                | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%              | Cinema        | CE 542E        |
|                |                          | 120 MV RANGE                              |               |                |
| R-109          | 0811-1266                | Resistor, Prec, ww, 18K, 1%               | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%              | Cinema        | CE 542E        |
|                |                          | 600 MV RANGE                              |               |                |
| R-109          | 0811-1267                | Resistor, Prec, ww, 98K, 1%               | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%              | Cinema        | CE 542E        |
|                |                          | 1.2 V RANGE                               |               |                |
| R-109          | 0811-1268                | Resistor, Prec, ww, 198K, 1%              | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%              | Cinema        | CE 542E        |
|                |                          | 6 V RANGE                                 |               |                |
| R-109          | 0811-1269                | Resistor, Prec, ww, 1M, 1%                | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%              | Cinema        | CE 542E        |
|                |                          | 12 V RANGE                                |               |                |
| R-109          | 0811-1271                | Resistor, Prec, ww, 2M, 1%                | Cinema        | CE 542E        |
| R-111          | 0811-0262                | Resistor, Prec, ww, 2K, 1%                | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%             | Allen-Bradley |                |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%              | Cinema        | CE 542E        |

FIGURE 6-3. FACTORY SELECTED RESISTORS FOR VARIOUS RANGES  
IN 681/681M (Sheet 3 of 4)

| Circuit Symbol | Hewlett-Packard Part No. | Description                     | Typical Mfr.  | Mfrs. Part No. |
|----------------|--------------------------|---------------------------------|---------------|----------------|
| 60 V RANGE     |                          |                                 |               |                |
| R-109          | 0811-1271                | Resistor, Prec, ww, 2M, 1%      | Cinema        | CE 542E        |
| R-111          | 0811-1262                | Resistor, Prec, ww, 500 ohm, 1% | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%   | Allen-Bradley | CE 542E        |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%    | Cinema        |                |
| 120 V RANGE    |                          |                                 |               |                |
| R-109          | 0811-1271                | Resistor, Prec, ww, 2M, 1%      | Cinema        | CE 542E        |
| R-111          | 0811-1277                | Resistor, Prec, ww, 222 ohm, 1% | Cinema        | CE 542E        |
| R-119          | 0683-1025                | Resistor, Comp, 1K, 1/4 w, 5%   | Allen-Bradley | CE 542E        |
| R-124          | 0811-1279                | Resistor, Prec, ww, 2.4K, 1%    | Cinema        |                |

FIGURE 6-3. FACTORY SELECTED RESISTORS FOR VARIOUS RANGES  
IN 681/681M (Sheet 4 of 4)

| Circuit<br>Symbol | Hewlett-<br>Packard<br>Part No. | Description                            | Typical<br>Mfr. | Mfrs.<br>Part No. |
|-------------------|---------------------------------|--|-----------------|-------------------|
|                   |                                 | 60 CPS                                 |                 |                   |
|                   | 3140-0060                       | Motor - 1 IN/MIN and 1 IN/HR           |                 |                   |
|                   | 3140-0060                       | Motor - 2 IN/MIN and 2 IN/HR           |                 |                   |
|                   | 3140-0060                       | Motor - 4 IN/MIN and 4 IN/HR           |                 |                   |
|                   | 3140-0060                       | Motor - 8 IN/MIN and 8 IN/HR           |                 |                   |
|                   | D-13665                         | Motor - 15 IN/MIN and 15 IN/HR         |                 |                   |
|                   | D-13666                         | Motor - 30 IN/MIN and 30 IN/HR         |                 |                   |
|                   | D-13667                         | Motor - 60 IN/MIN and 60 IN/HR         |                 |                   |
|                   |                                 | 50 CPS                                 |                 |                   |
|                   | 3140-0061                       | Motor - 1 IN/MIN and 1 IN/HR           |                 |                   |
|                   | 3140-0061                       | Motor - 2 IN/MIN and 2 IN/HR           |                 |                   |
|                   | 3140-0061                       | Motor - 4 IN/MIN and 4 IN/HR           |                 |                   |
|                   | 3140-0061                       | Motor - 8 IN/MIN and 8 IN/HR           |                 |                   |
|                   | D-13665                         | Motor - 12-1/2 IN/MIN and 12-1/2 IN/HR |                 |                   |
|                   | D-13666                         | Motor - 25 IN/MIN and 25 IN/HR         |                 |                   |
|                   | D-13667                         | Motor - 50 IN/MIN and 50 IN/HR         |                 |                   |

FIGURE 6-4. CHART DRIVE MOTOR

## SECTION VII CIRCUIT DIAGRAMS AND COMPONENT IDENTIFICATION

### 7-1. INTRODUCTION

7-2. This section contains mechanical parts identification (exploded views), and component location photos accompanied by the appropriate circuit diagram.

### 7-3. MECHANICAL PARTS IDENTIFICATION

7-4. A thorough breakdown of mechanical and electromechanical components is provided in figures 7-2

through 7-5. These illustrations are useful for parts identification and assembly/disassembly information.

### 7-5. CIRCUIT DIAGRAMS

7-6. Figures next to schematics are component location photos that show the physical location of each component. They accompany the appropriate schematic.



| Item | Part No.  | Description          | Qty    | Item | Part No.  | Description         | Qty      |
|------|-----------|----------------------|--------|------|-----------|---------------------|----------|
| 1    | A9423     | Syringe              | 1 each | 6    | 5080-3635 | Slidewire Lubricant | 1 Bottle |
| 2    | A15126    | Pen Cleaning Wire    | 1 each | 7    | 5080-3605 | Slidewire Cleaner   | 1 Can    |
| 3    | 1530-0095 | Ink Cartridge - Blue | 4 each | 8    | 9211-0343 | Plastic Box         | 1 each   |
| 4    | 1530-0703 | Ink Cartridge - Red  | 4 each | 9    | M18464    | Pen Assembly        | 1 each   |
| 5    | 1251-0405 | "Tini-Plug" #750     | 1 each |      |           |                     |          |

FIGURE 7-1. ACCESSORY KIT (M18547)

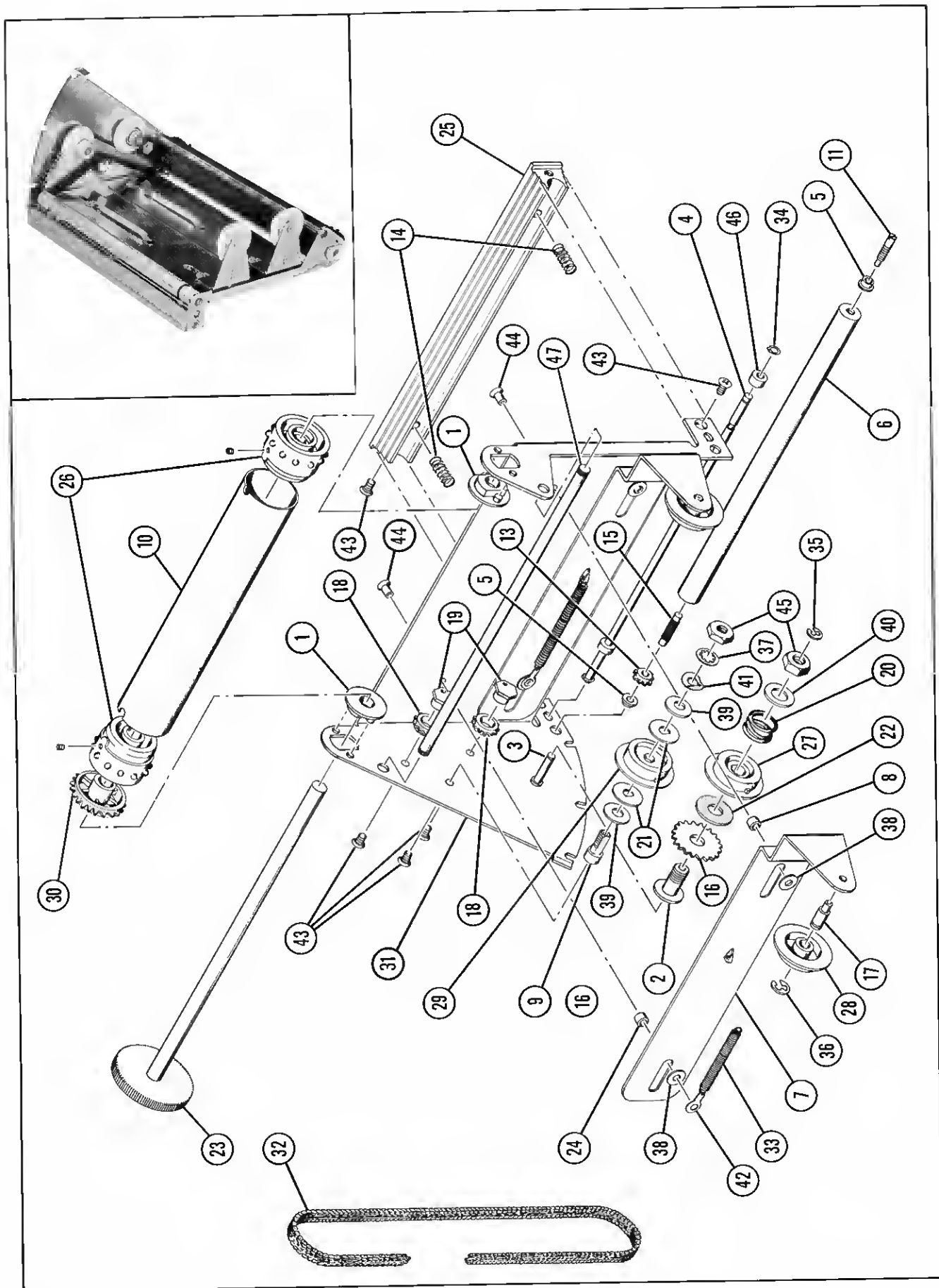


FIGURE 7-2. EXPLODED VIEW OF CHART MAGAZINE (Sheet 1 of 2)



# CHART MAGAZINE ASSEMBLY - P/N M10064

## LEGEND FOR FIGURE 7-2

| Item | Part No.    | Description           | Mfr<br>Designation |
|------|-------------|-----------------------|--------------------|
| 1    | A-9554      | Bushing, Pivot        | Hewlett-Packard    |
| 2    | A-9555      | Bearing, Clutch       | Hewlett-Packard    |
| 3    | A-9557      | Shaft                 | Hewlett-Packard    |
| 4    | A-9559      | Roller, Tension       | Hewlett-Packard    |
| 5    | A-9561      | Bushing               | Hewlett-Packard    |
| 6    | M-10070     | Roller Assy           | Hewlett-Packard    |
| 7    | A-9568      | Bracket, Slide        | Hewlett-Packard    |
| 8    | A-9570      | Spacer                | Hewlett-Packard    |
| 9    | A-9626      | Stud                  | Hewlett-Packard    |
| 10   | A-9628      | Drum                  | Hewlett-Packard    |
|      | 17999-19711 | Drum (Metric)         | Hewlett-Packard    |
| 11   | A-9744      | Shaft                 | Hewlett-Packard    |
| 12   | A-9772      | Rod, Paper Guide      | Hewlett-Packard    |
| 13   | A-9839      | Sprocket              | Hewlett-Packard    |
| 14   | A-16825     | Spring                | Hewlett-Packard    |
| 15   | A-10372     | Shaft                 | Hewlett-Packard    |
| 16   | A-10375     | Sprocket, Take-up     | Hewlett-Packard    |
| 17   | A-10431     | Stud                  | Hewlett-Packard    |
| 18   | A-10447     | Sprocket, Idler       | Hewlett-Packard    |
| 19   | A-10448     | Bushing, Adjustment   | Hewlett-Packard    |
| 20   | A-10451     | Spring, Clutch        | Hewlett-Packard    |
| 21   | A-10624     | Washer                | Hewlett-Packard    |
| 22   | A-10978     | Disc, Take-up         | Hewlett-Packard    |
| 23   | A-11255     | Drum Shaft Assy       | Hewlett-Packard    |
| 24   | A-13893     | Spacer                | Hewlett-Packard    |
| 25   | B-9558      | Handle, Magazine      | Hewlett-Packard    |
| 26   | B-9869      | Sprocket              | Hewlett-Packard    |
|      | 5040-3104   | Sprocket, LH (Metric) |                    |
|      | 5020-4230   | Sprocket, RH (Metric) |                    |
| 27   | B-10336     | Hub, Take-up          | Hewlett-Packard    |
| 28   | B-10338     | Hub                   | Hewlett-Packard    |
| 29   | B-10339     | Hub                   | Hewlett-Packard    |
| 30   | B-10729     | Sprocket              | Hewlett-Packard    |
| 31   | C-9614      | Frame                 | Hewlett-Packard    |
| 32   | 1530-0020   | Chain (12")           | Hewlett-Packard    |
| 33   | 1460-0190   | Spring                |                    |
| 34   | 0510-0082   | Retainer, Ring        | Tru-Arc            |
| 35   | 0510-0015   | Retainer, Ring        | Tru-Arc            |
| 36   | 0510-0263   | Retainer, Ring        | Tru-Arc            |
| 37   | 2190-0011   | Washer                |                    |
| 38   | 360-0030    | Washer, #4            |                    |
| 39   | 3050-0226   | Washer                |                    |
| 40   | 2190-0152   | Washer, Flat          |                    |
| 41   | 2190-0155   | Washer                |                    |
| 42   | 0360-0073   | Solder Lug            |                    |
| 43   | 2200-0056   | Screw                 |                    |
| 44   | 0361-0208   | Rivet                 |                    |
| 45   | 2740-0002   | Nut, 10-32            |                    |
| 46   | 1410-0257   | Bushing               |                    |
| 47   | A-9772      | Rod, Paper Guide      | Hewlett-Packard    |

FIGURE 7-2. EXPLODED VIEW OF CHART MAGAZINE (Sheet 2 of 2)

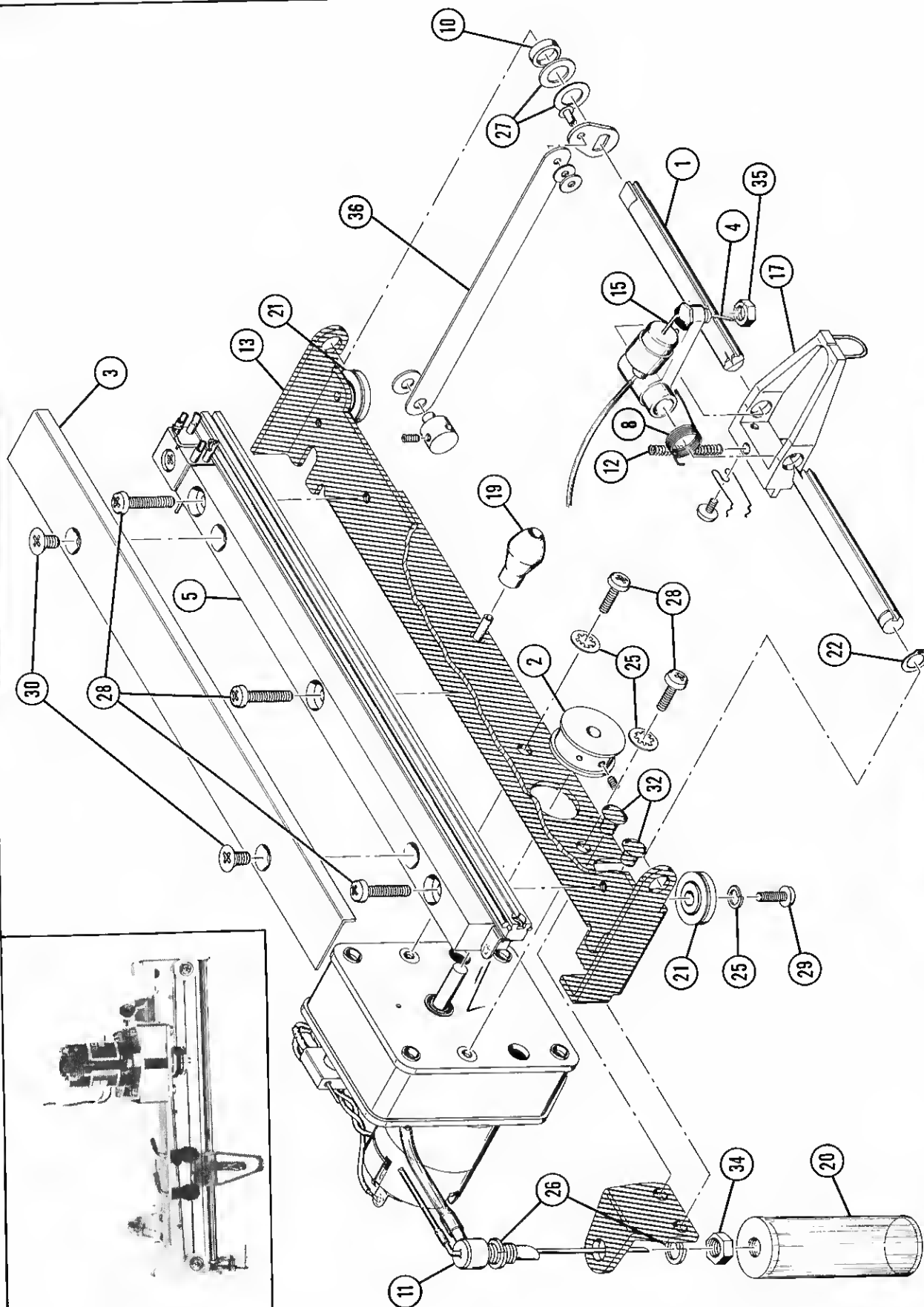


FIGURE 7-3. EXPLODED VIEW OF PEN CARRIAGE (Sheet 1 of 2)

LEGEND FOR FIGURE 7-3

| <u>Item</u> | <u>Part No.</u> | <u>Description</u>    | <u>Mfr<br/>Designation</u> |
|-------------|-----------------|-----------------------|----------------------------|
| 1           | A9548           | Rod                   | Hewlett-Packard            |
| 2           | A9699           | Sheave                | Hewlett-Packard            |
| 3           | A9706           | Cover                 | Hewlett-Packard            |
| 4           | M-18464         | Pen Tip               | Hewlett-Packard            |
| 5           | A10082          | Potentiometer Assy    | Hewlett-Packard            |
| 8           | A10194          | Spring, Holddown      | Hewlett-Packard            |
| 10          | A10533          | Spacer                | Hewlett-Packard            |
| 11          | A10586          | Holder, Ink Cartridge | Hewlett-Packard            |
| 12          | A10678          | Spring, Tension       | Hewlett-Packard            |
| 13          | 17999-19055     | Bracket Assy          | Hewlett-Packard            |
| 15          | A18368          | Holder, Pen           | Hewlett-Packard            |
| 17          | 17999-14106     | Slider Block Assy     | Hewlett-Packard            |
| 19          | 1530-0096       | Bulb                  |                            |
| 20          | 1530-0703       | Ink Cartridge (Red)   | Hewlett-Packard            |
| 21          | 1410-0276       | Ball Bearing          |                            |
| 22          | 0510-0238       | Ring Retaining        |                            |
| 25          | 2190-0108       | Washer, Split         |                            |
| 26          | 2190-0087       | Washer, Split         |                            |
| 27          | 2190-0181       | Washer                |                            |
| 28          | 2200-0049       | Screw                 |                            |
| 29          | 2270-0020       | Screw                 |                            |
| 30          | 2200-0056       | Screw, Flat Head      |                            |
| 34          | 2580-0002       | Nut, 8-32 x 1/4       |                            |
| 35          | 0540-0003       | Nut, 5-40             |                            |
| 36          | A10681          | Pen Lift Arm Assy     | Hewlett-Packard            |

FIGURE 7-3. EXPLODED VIEW OF PEN CARRIAGE (Sheet 2 of 2)

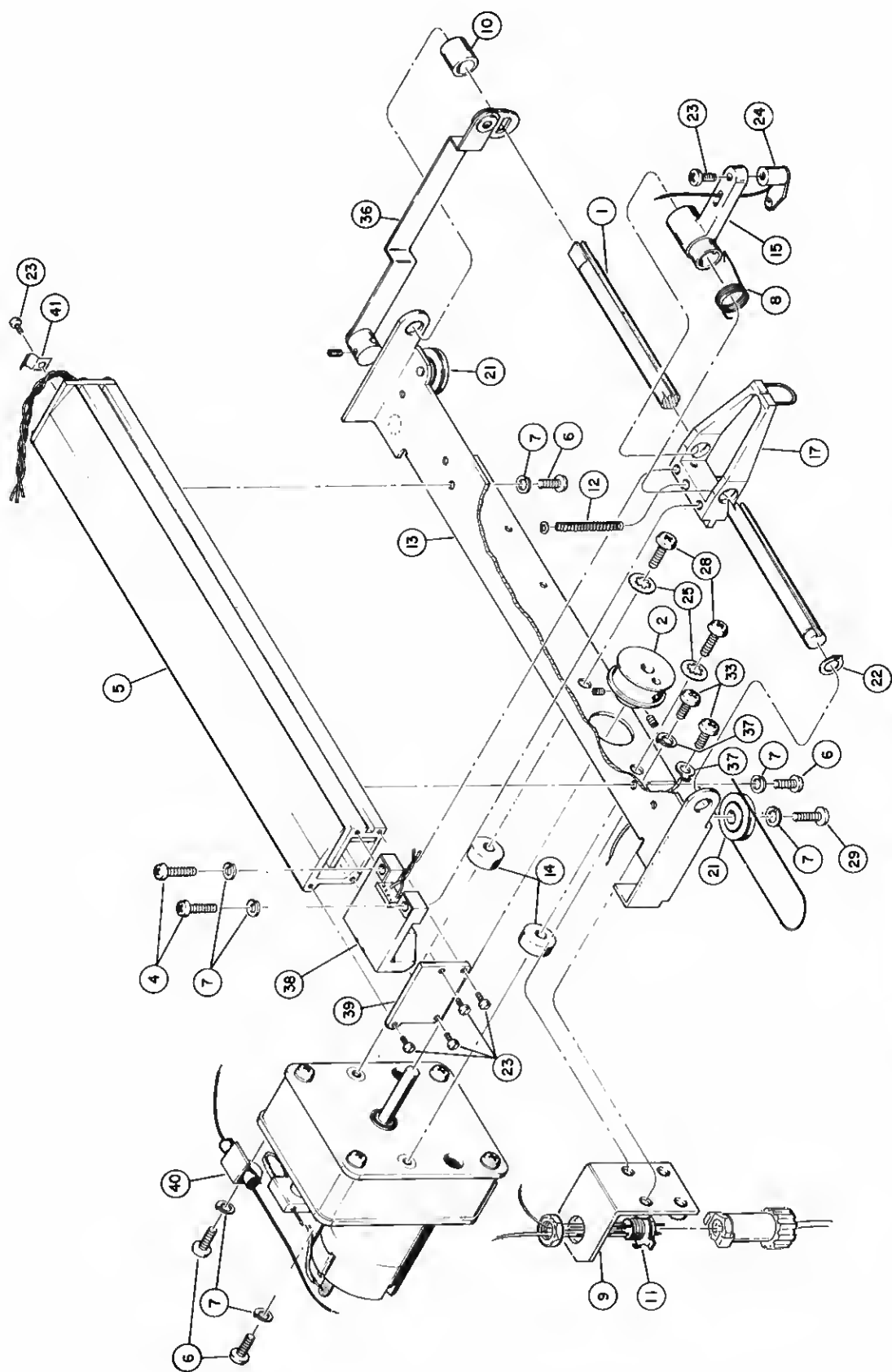


FIGURE 7-4. EXPLODED VIEW OF PEN CARRIAGE WITH ELECTRIC STYLUS AND PHOTO SLIDEWIRE (Sheet 1 of 2)

LEGEND FOR FIGURE 7-4

| <u>Item</u> | <u>Part No.</u> | <u>Description</u>              | <u>Mfr<br/>Designation</u> |
|-------------|-----------------|---------------------------------|----------------------------|
| 1           | A9548           | Rod                             |                            |
| 2           | A9699           | Sheave                          |                            |
| 3           |                 | Not Used                        |                            |
| 4           | 0520-0083       | Screw, 2-56 x 7/16              |                            |
| 5           | 17999-19063     | Photo-slidewire Assy (Complete) |                            |
| 6           | 0520-0066       | Screw, 2-56 x 3/16              |                            |
| 7           | 2190-0112       | Washer, Lock                    |                            |
| 8           | A10194          | Spring, Holddown                |                            |
| 9           | 17999-19576     | Bracket, Connector              |                            |
| 10          | 17999-19022     | Spacer                          |                            |
| 11          | 1251-1316       | Connector                       |                            |
| 12          | A10678          | Spring, Tension                 |                            |
| 13          | A10679          | Bracket Assy                    |                            |
| 14          | 0380-0134       | Spacer, Motor                   |                            |
| 15          | 17999-10899     | Stylus Holder                   |                            |
| 16          |                 | Not Used                        |                            |
| 17          | 17999-19057     | Guard Assy, Pen                 |                            |
| 18          |                 | Not Used                        |                            |
| 19          |                 | Not Used                        |                            |
| 20          |                 | Not Used                        |                            |
| 21          | 1410-0276       | Ball Bearing                    |                            |
| 22          | 0510-0238       | Ring, Retaining                 |                            |
| 23          | 0570-0030       | Screw, 0-80                     |                            |
| 24          | 17999-19657     | Electric Stylus Assy            |                            |
| 25          | 2190-0108       | Washer, Split                   |                            |
| 26          |                 | Not Used                        |                            |
| 27          |                 | Not Used                        |                            |
| 28          | 2200-0049       | Screw                           |                            |
| 29          | 2270-0020       | Screw                           |                            |
| 30          |                 | Not Used                        |                            |
| 31          |                 | Not Used                        |                            |
| 32          |                 | Not Used                        |                            |
| 33          | 0570-0125       | Screw, 4-40 x 3/16              |                            |
| 34          |                 | Not Used                        |                            |
| 35          |                 | Not Used                        |                            |
| 36          | 17999-19025     | Arm, Pen Lift                   |                            |
| 37          | 2190-0108       | Washer, Lock, Split #4          |                            |
| 38          | 17999-19017     | Light, Block Assy               |                            |
| 39          | 17999-18522     | End Plate (LH)                  |                            |
| 40          | 17999-19056     | Clomp, Bulb Wire                |                            |
| 41          | 17999-19018     | Clamp, Cable                    |                            |

FIGURE 7-4. EXPLODED VIEW OF PEN CARRIAGE WITH ELECTRIC STYLUS AND PHOTO SLIDEWIRE  
(Sheet 2 of 2)

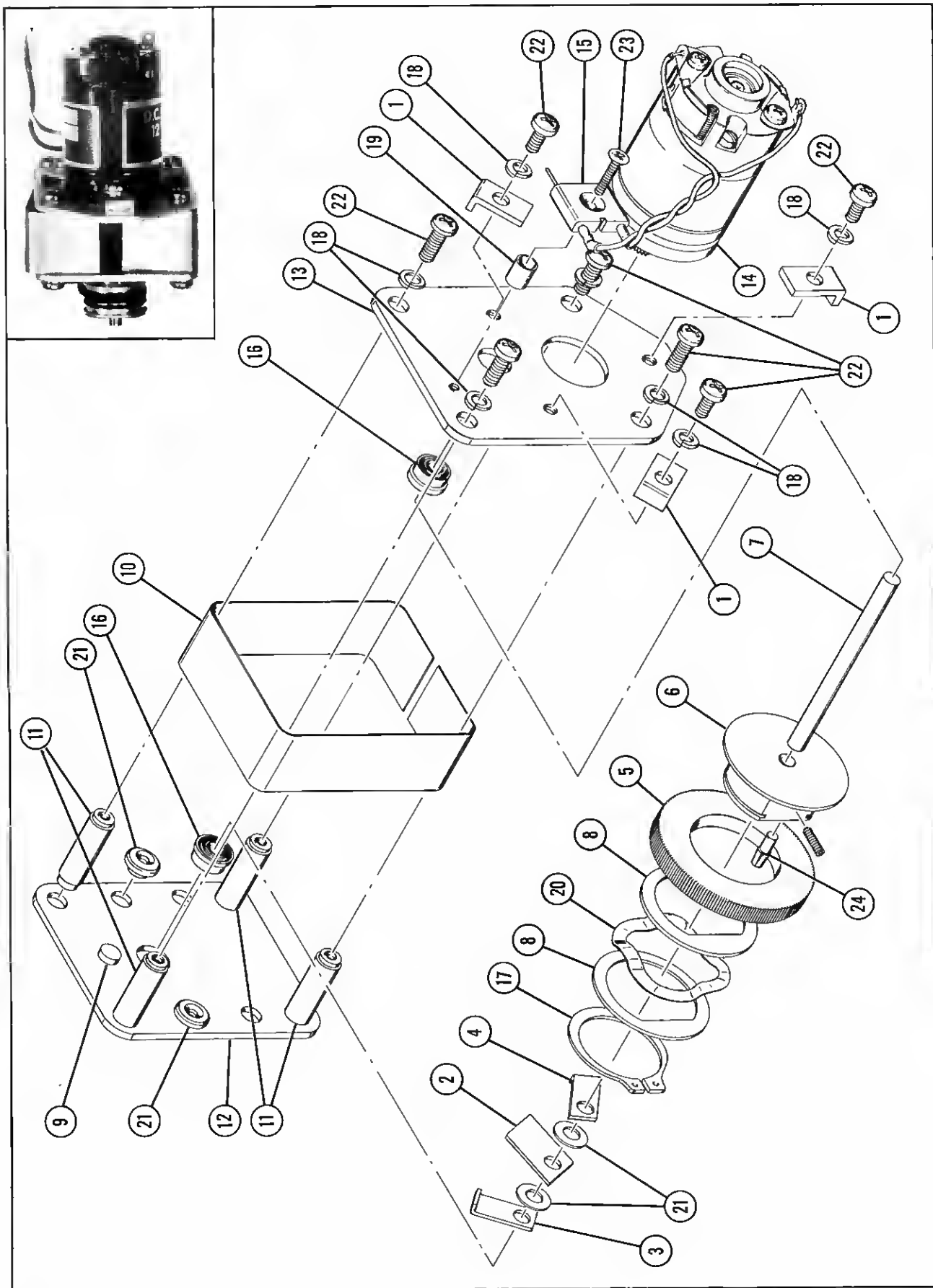
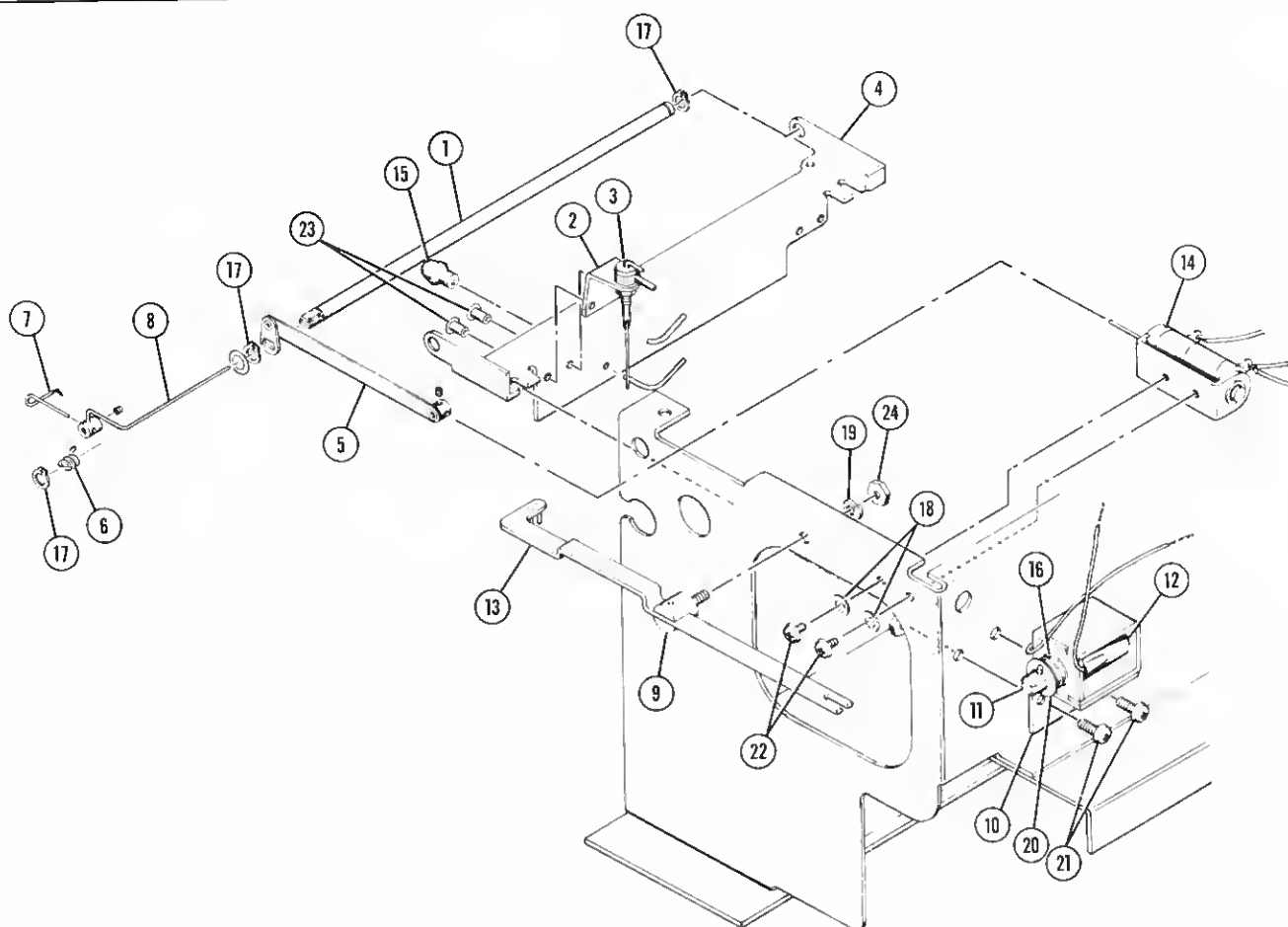


FIGURE 7-5. EXPLODED VIEW OF GEAR ASSEMBLY (P/N A10083) (Sheet 1 of 2)

LEGEND FOR FIGURE 7-5

| <u>Item</u> | <u>Part No.</u> | <u>Description</u>      | <u>Mfr</u><br><u>Designation</u> |
|-------------|-----------------|-------------------------|----------------------------------|
| 1           | A-0033          | Bracket                 | Hewlett-Packard                  |
| 2           | A-10202         | Plate                   | Hewlett-Packard                  |
| 3           | A-10200-1       | Finger                  | Hewlett-Packard                  |
| 4           | A-10200-2       | Finger                  | Hewlett-Packard                  |
| 5           | A-10346         | Gear                    | Hewlett-Packard                  |
| 6           | A-10347         | Bushing                 | Hewlett-Packard                  |
| 7           | A-10348         | Shaft                   | Hewlett-Packard                  |
| 8           | A-10351         | Ring, Pressure          | Hewlett-Packard                  |
| 9           | A-10365         | Pin, Stop               | Hewlett-Packard                  |
| 10          | A-10608         | Cover                   | Hewlett-Packard                  |
| 11          | A-10609         | Stand-off               | Hewlett-Packard                  |
| 12          | A-10768         | Plate, Mounting         | Hewlett-Packard                  |
| 13          | A-10769         | Plate, Mounting         | Hewlett-Packard                  |
| 14          | A-10822         | DC Motor                | Hewlett-Packard                  |
| 15          | 1251-1113       | Connector               |                                  |
| 16          | 1410-0273       | Ball Bearing SFR 1445P1 |                                  |
| 17          | 0510-0814       | Ring, Retaining         |                                  |
| 18          | 2190-0108       | Washer, Split           |                                  |
| 19          | 0380-0177       | Spacer                  |                                  |
| 20          | 2190-0174       | Washer, Spring WB24     |                                  |
| 21          | 3050-0394       | Washer, Flat, 0.02 Shim |                                  |
| 22          | 2270-0020       | Screw                   |                                  |
| 23          | 0520-0106       | Screw, Flathead         |                                  |
| 24          | 0510-0854       | Pin, Stop               |                                  |

FIGURE 7-5. EXPLODED VIEW OF GEAR ASSEMBLY (P/N A10083) (Sheet 2 of 2)



| <u>Item</u> | <u>Part No.</u> | <u>Description</u>    | <u>Mfr Designation</u> |
|-------------|-----------------|-----------------------|------------------------|
| 1           | A11522          | Rod                   | Hewlett-Packard        |
| 2           | A10476          | Bracket               | Hewlett-Packard        |
| 3           | A10534          | Holder, Ink Cartridge | Hewlett-Packard        |
| 4           | A10679          | Bracket Assy          | Hewlett-Packard        |
| 5           | A10681          | Arm                   | Hewlett-Packard        |
| 6           | A11165          | Springs, Return       | Hewlett-Packard        |
| 7           | B-18203         | Pen Assembly          | Hewlett-Packard        |
| 8           | A12211          | Pen Holder            | Hewlett-Packard        |
| 9           | A12212          | Pivot                 | Hewlett-Packard        |
| 10          | A12215          | Bracket               | Hewlett-Packard        |
| 11          | A12250          | Plunger, Solenoid     | Hewlett-Packard        |
| 12          | A12251          | Coil, Solenoid        | Hewlett-Packard        |
| 13          | A12297          | Actuator Arm Assy     | Hewlett-Packard        |
| 14          | A13046          | Solenoid, Pen Lift    | Hewlett-Packard        |
| 15          | 1530-0096       | Bulb                  |                        |
| 16          | 1460-0254       | Spring, Solenoid      |                        |
| 17          | 0510-0238       | Ring, Retaining       |                        |
| 18          | 2190-0108       | Washer, Split         |                        |
| 19          | 2190-0105       | Washer, Split         |                        |
| 20          | 3050-0386       | Washer                |                        |
| 21          | 2460-0033       | Screw                 |                        |
| 22          | 2200-0056       | Screw                 |                        |
| 23          | 0361-0137       | Rivet                 |                        |
| 24          | 2420-0010       | Nut                   |                        |

FIGURE 7-6. EXPLODED VIEW OF INK EVENT MARKER ASSEMBLY



## WAVEFORM NOTES

The waveforms on the schematics were taken with a Hewlett-Packard Model 130C oscilloscope, of a 680 series recorder of known quality. Test points may be made accessible by removing the top and bottom covers.

To obtain error signal:

- a. Manually move pen one sub division ( $1/10''$ , 2.54 mm).
- b. Note error signal on scope.
- c. Using zero control suppress zero (set zero beyond graph limits) for same amplitude signal. This allows a constant error signal without manually holding pen off null.

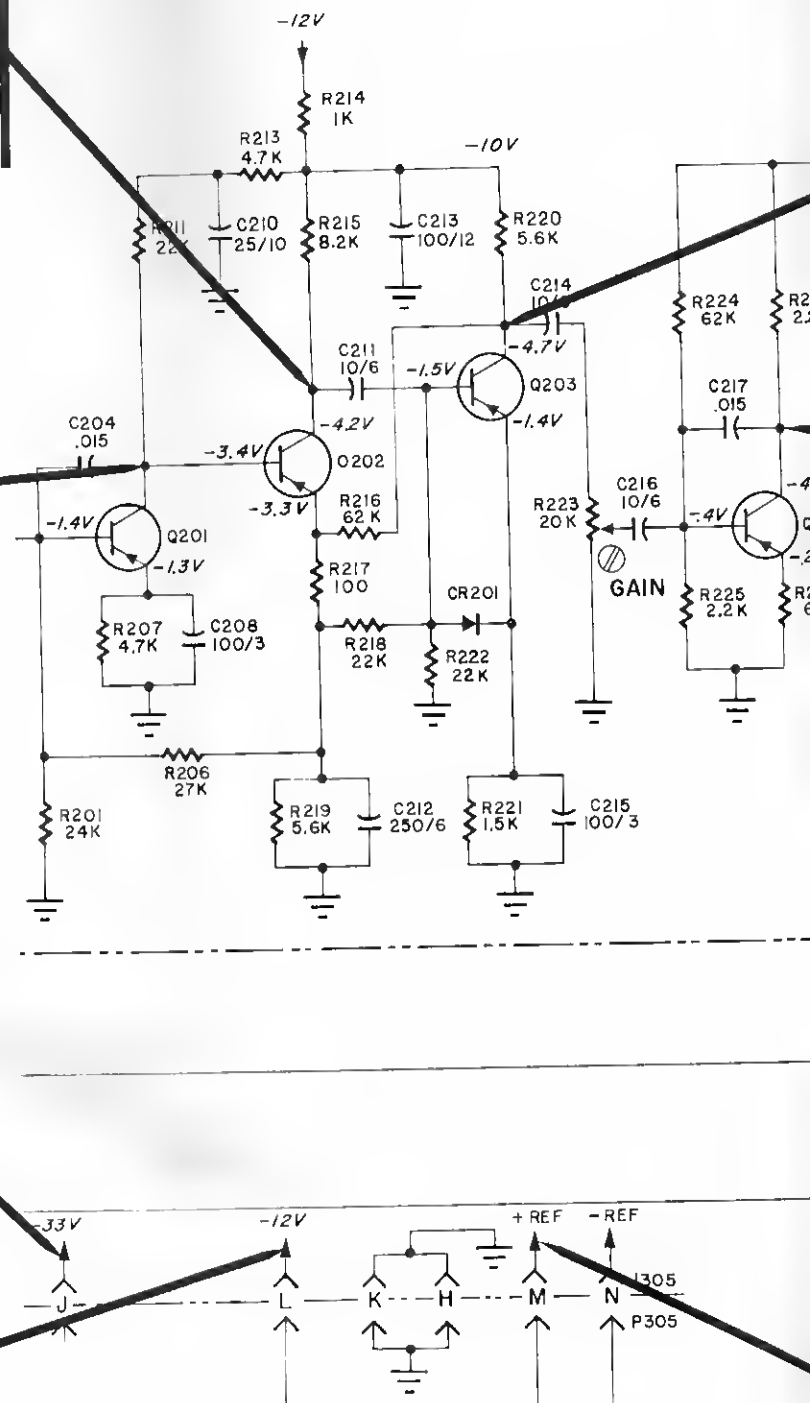
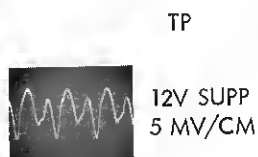
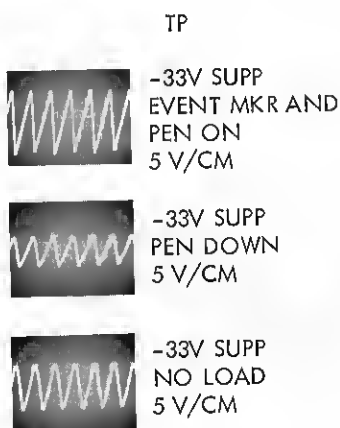
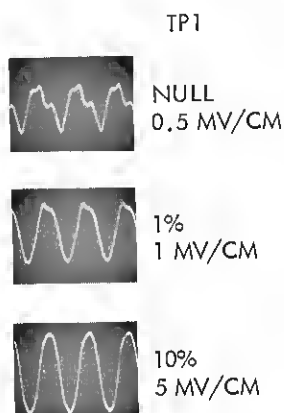
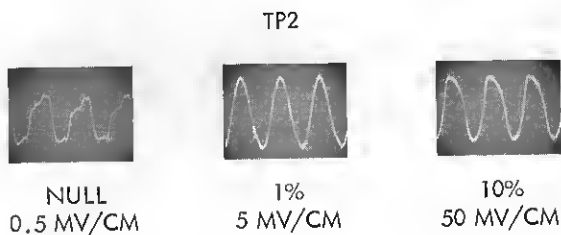
### GENERAL SETTINGS UNLESS OTHERWISE STATED

#### OSCILLOSCOPE SETTINGS

1. 5 ms/cm sweep speed.
2. Attenuator probe NOT used.
3. Observe scope polarity, negative side is connected to chassis ground.

#### RECORDER SETTINGS

1. Recorder must be grounded.
2. Short input terminals.
3. Recorder must be in normal operating position, i. e. , flat on table or horizontal in rack. Do not set on side as the weight of the carriage beam will cause an error signal.
4. Set the gain to 70% (mechanical) of its adjustable range.



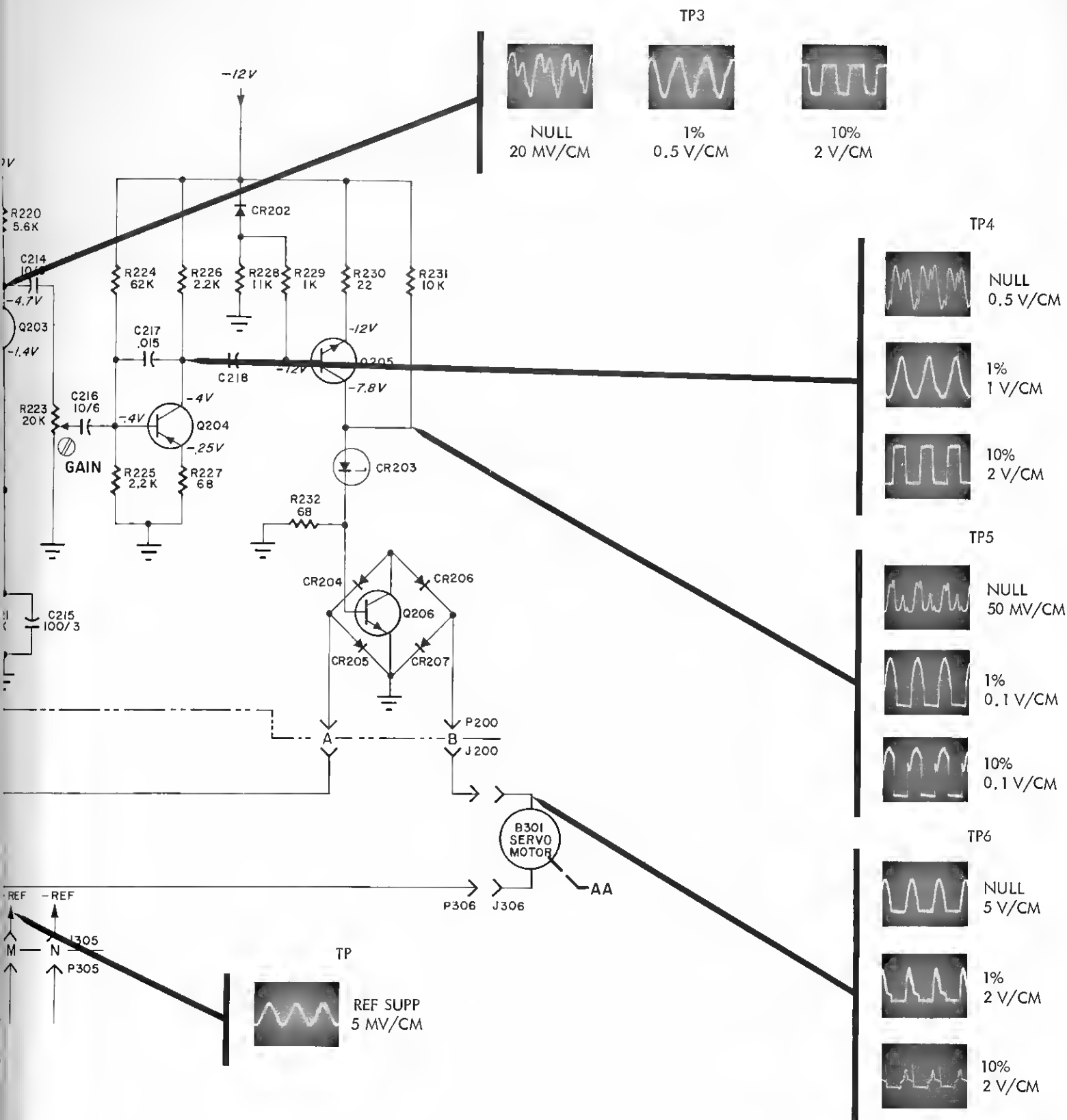


FIGURE 7-7. WAVEFORM

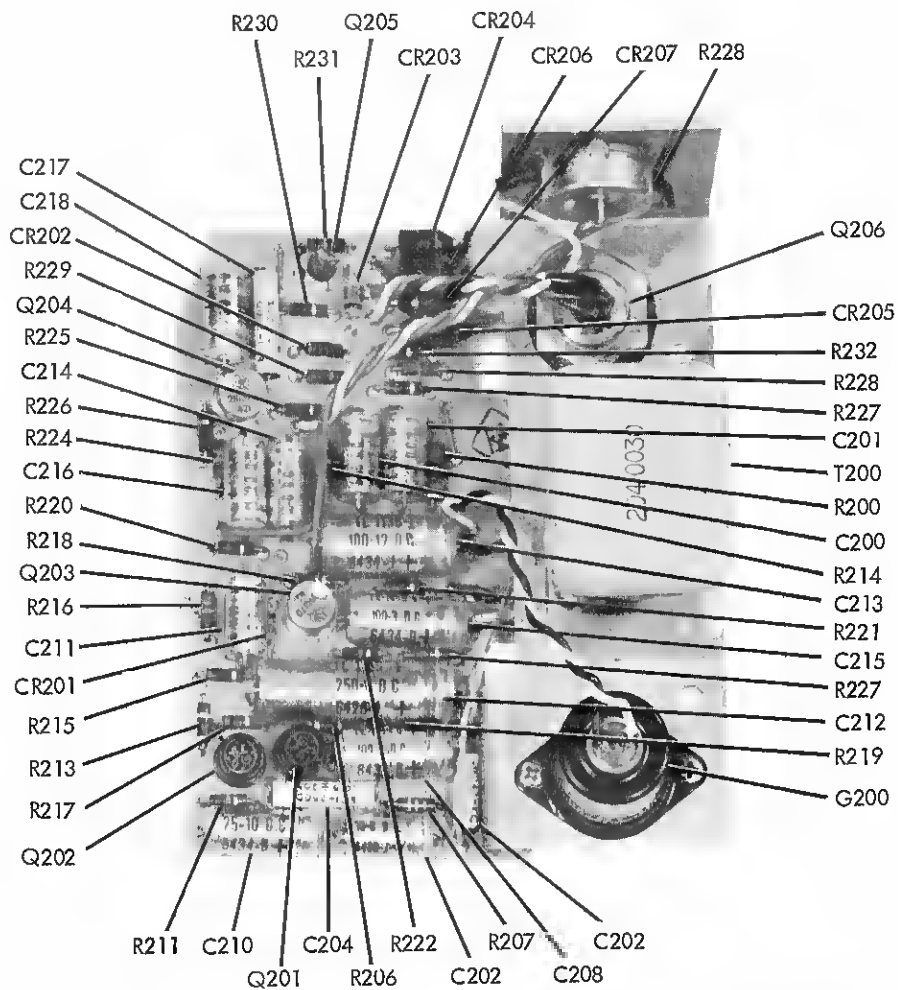


FIGURE 7-8. SERVO AMPLIFIER

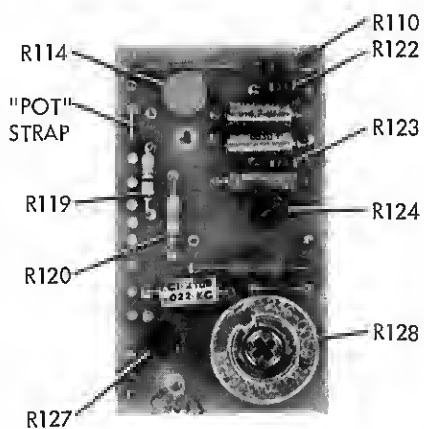


FIGURE 7-9. INPUT CIRCUIT BOARD

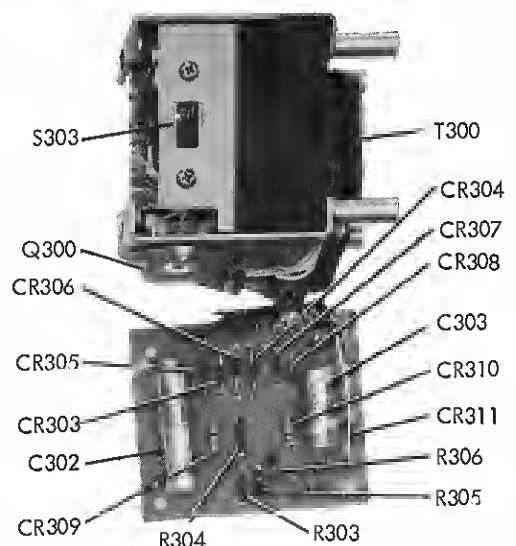


FIGURE 7-10. POWER SUPPLY

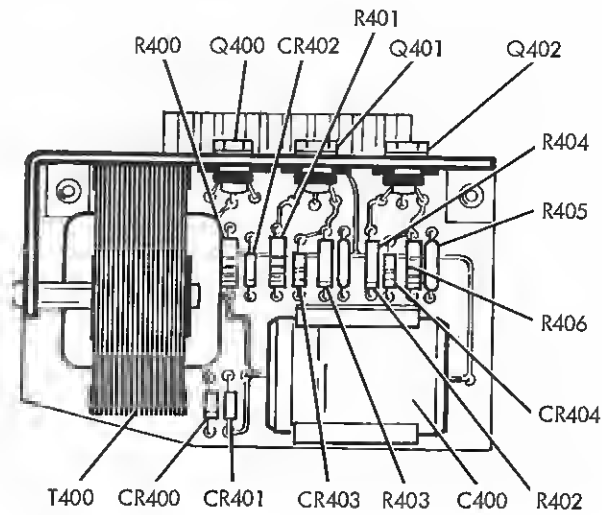


FIGURE 7-11. ELECTRIC WRITING POWER SUPPLY (P/N 5080-7794)

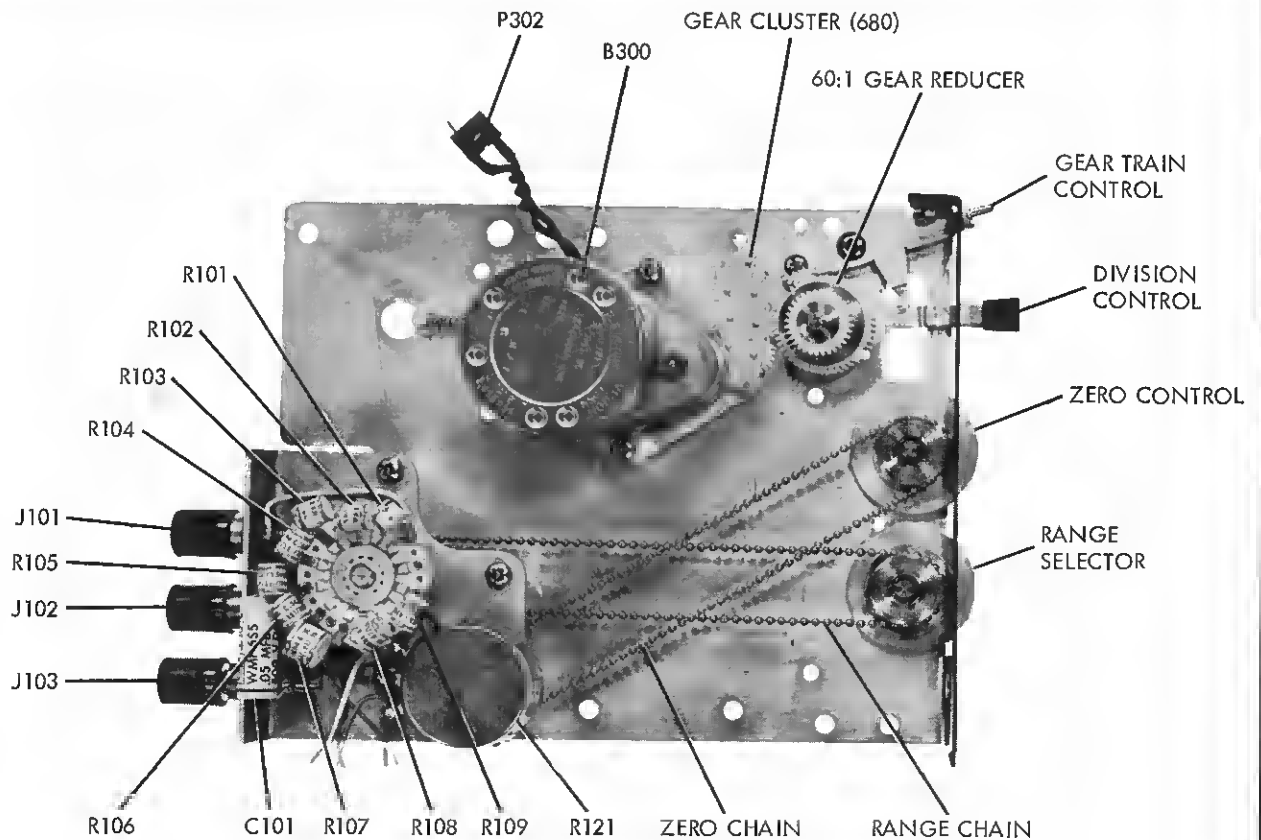
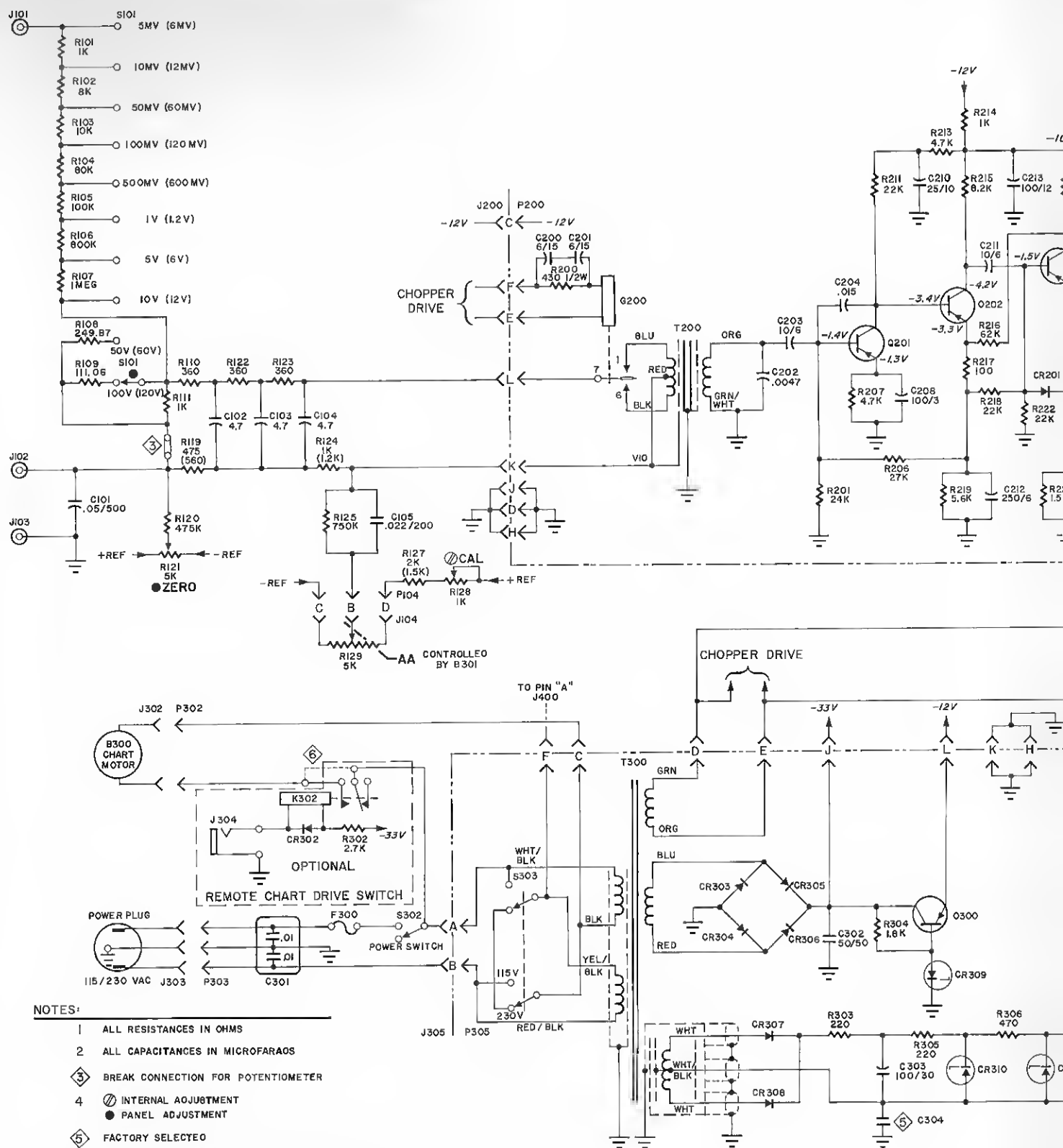


FIGURE 7-12. CHART DRIVE AND INPUT ASSEMBLY



# NOTES:

- 1 ALL RESISTANCES IN OHMS
- 2 ALL CAPACITANCES IN MICROFARADS
- 3 BREAK CONNECTION FOR POTENTIOMETER
- 4 INTERNAL ADJUSTMENT  
● PANEL ADJUSTMENT
- 5 FACTORY SELECTED
- 6 BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
- 7 NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODEL

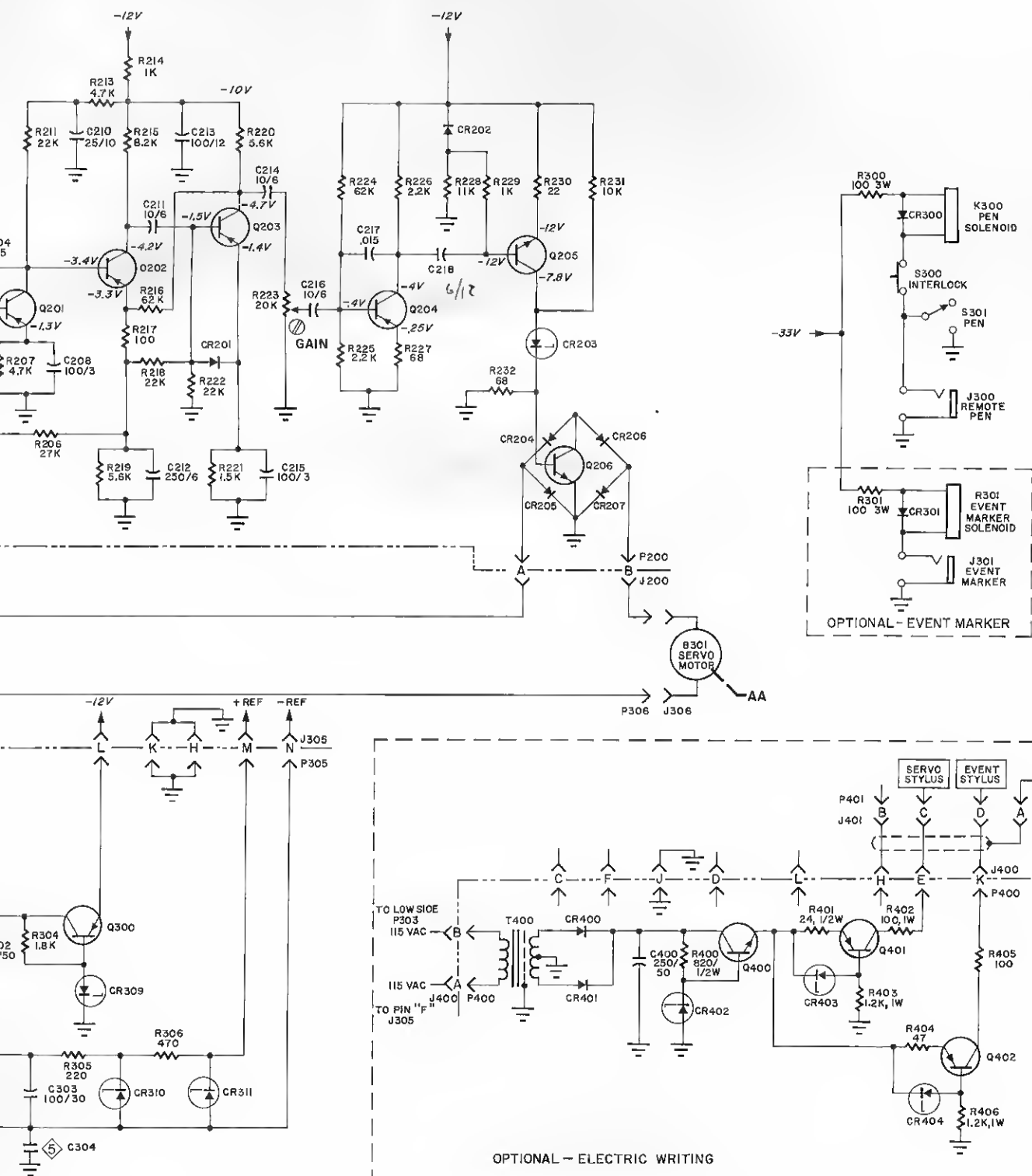


FIGURE 7-13. 680/68M SCHEMATIC D5950-7314

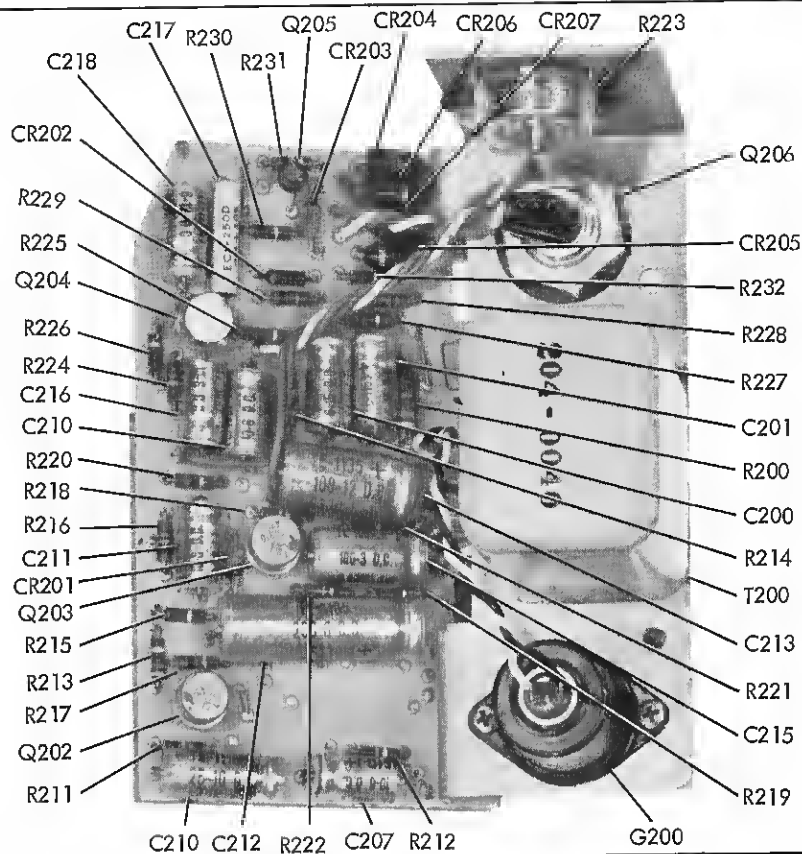


FIGURE 7-14. 100K INPUT SERVO AMPLIFIER

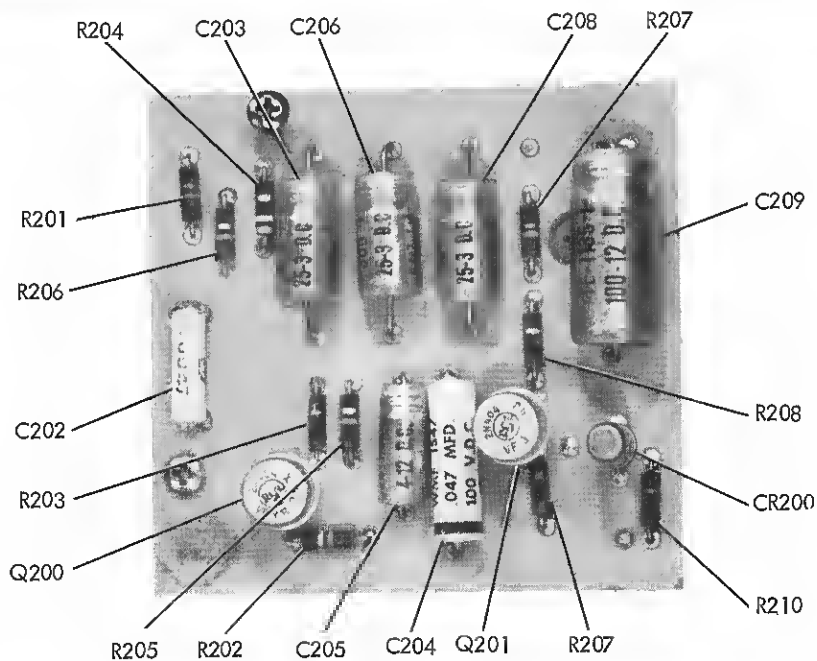
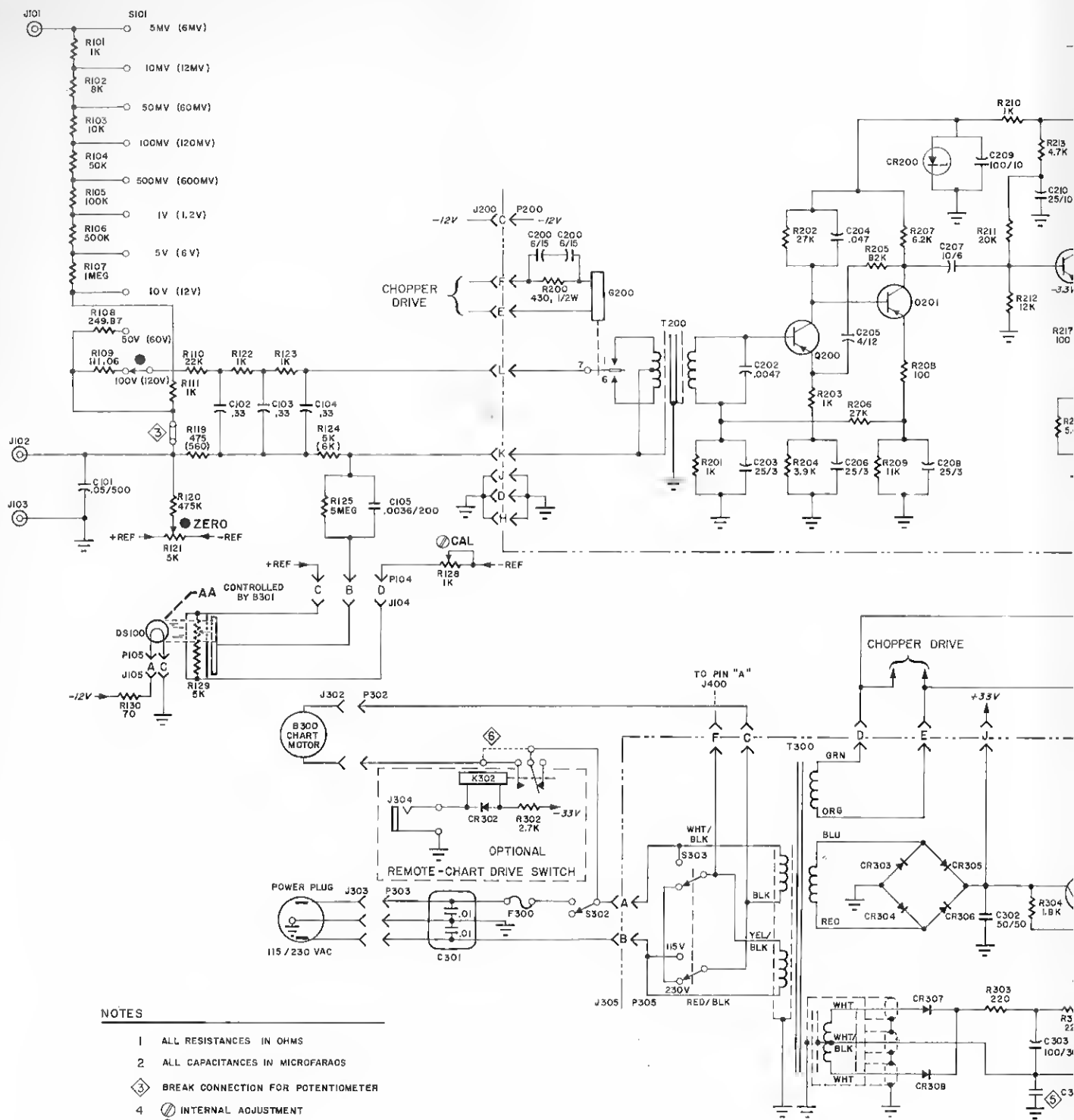


FIGURE 7-15. MODEL 680 (100K) PREAMPLIFIER





FIGURE 7-16. 680 BOTTOM VIEW



# NOTES

- 1 ALL RESISTANCES IN OHMS
- 2 ALL CAPACITANCES IN MICROFARADS
- ③ BREAK CONNECTION FOR POTENTIOMETER
- ⊗ INTERNAL ADJUSTMENT  
● PANEL ADJUSTMENT
- ⑤ FACTORY SELECTED
- ⑥ BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
- 7 NUMERALS IN PARENTHESES { } APPLY TO METRIC MODELS

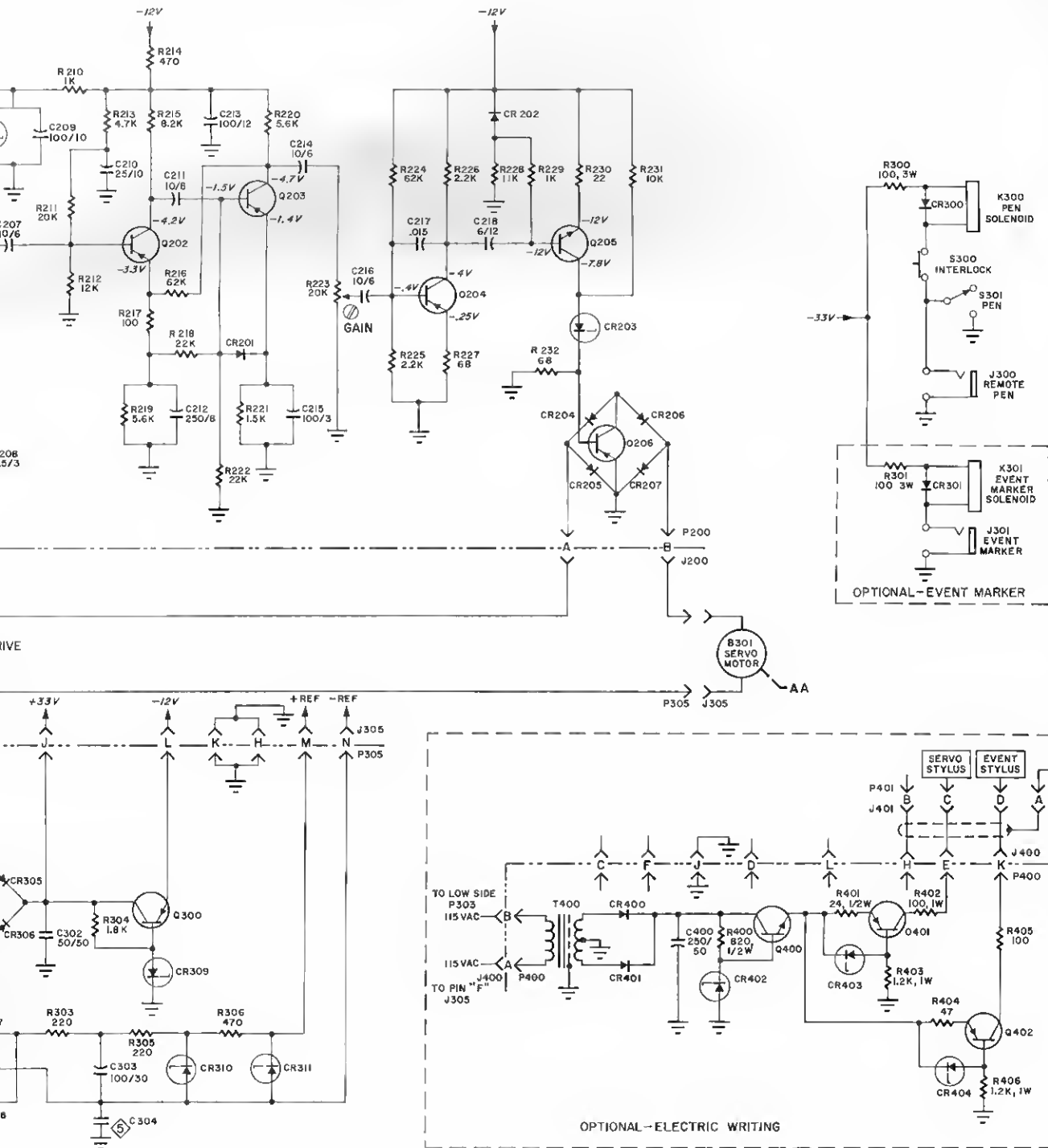
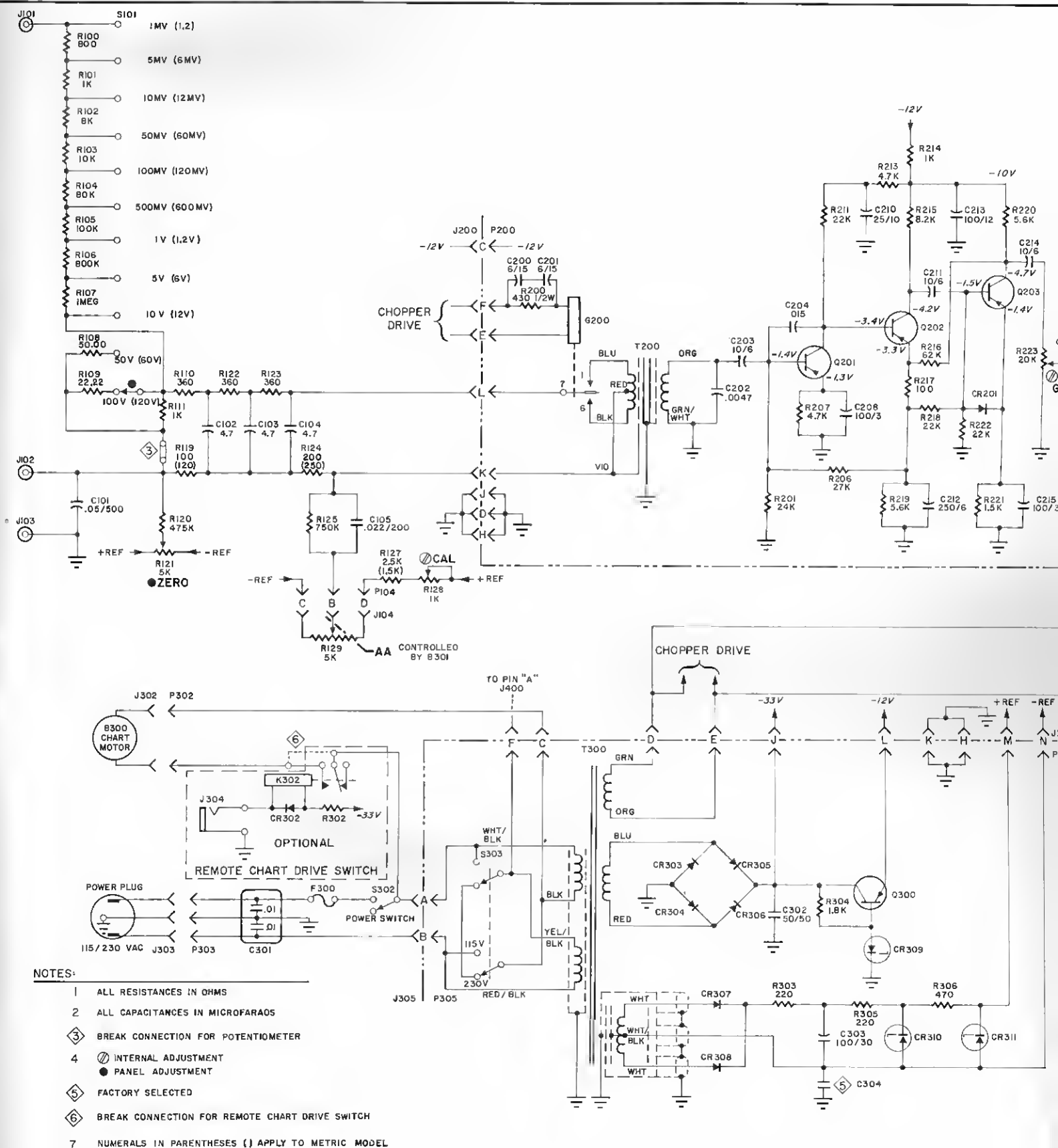


FIGURE 7-17. 680-17/680M-17  
SCHEMATIC D5950-7320



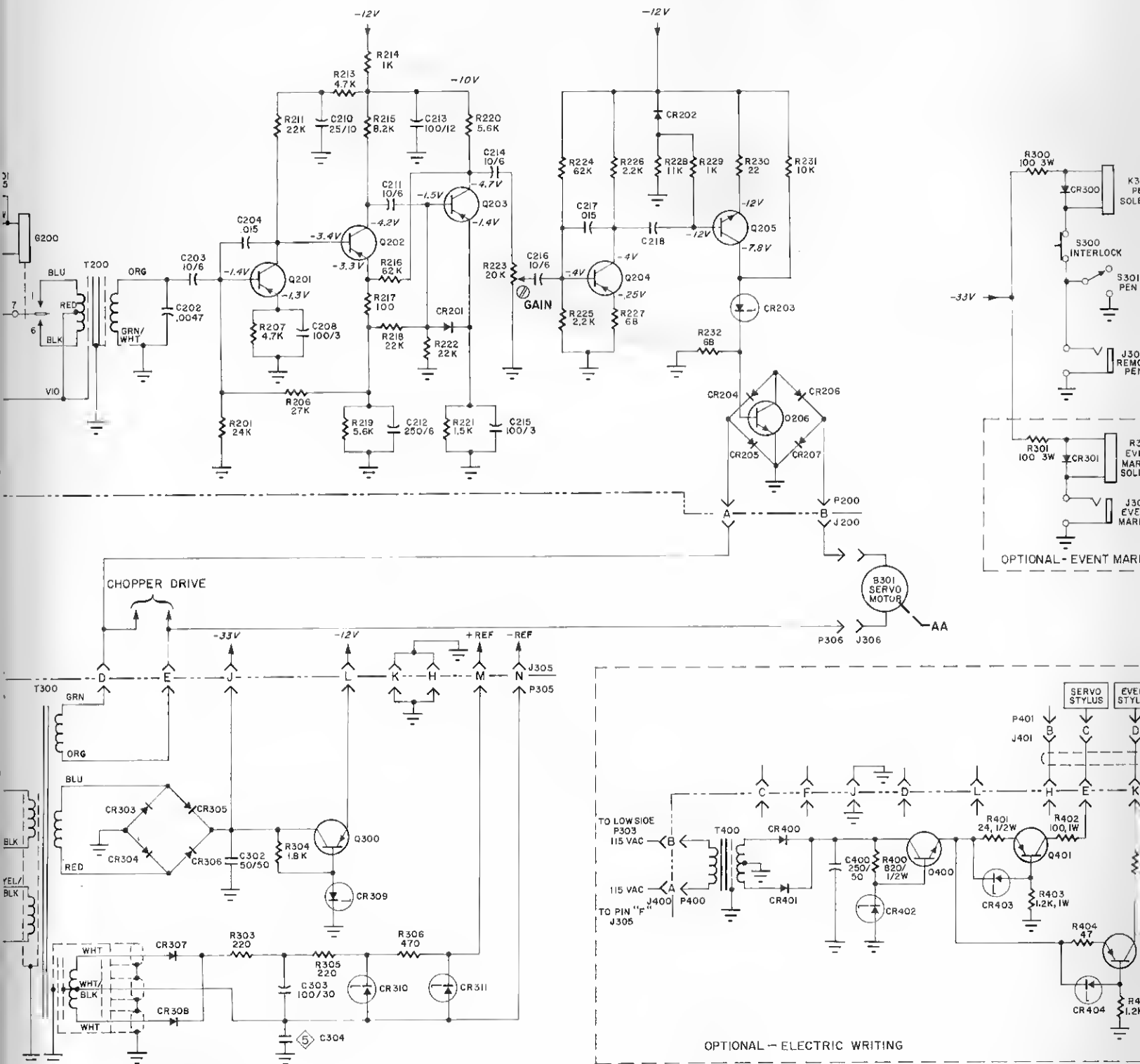


FIGURE 7-18. H  
SCHEMATIC

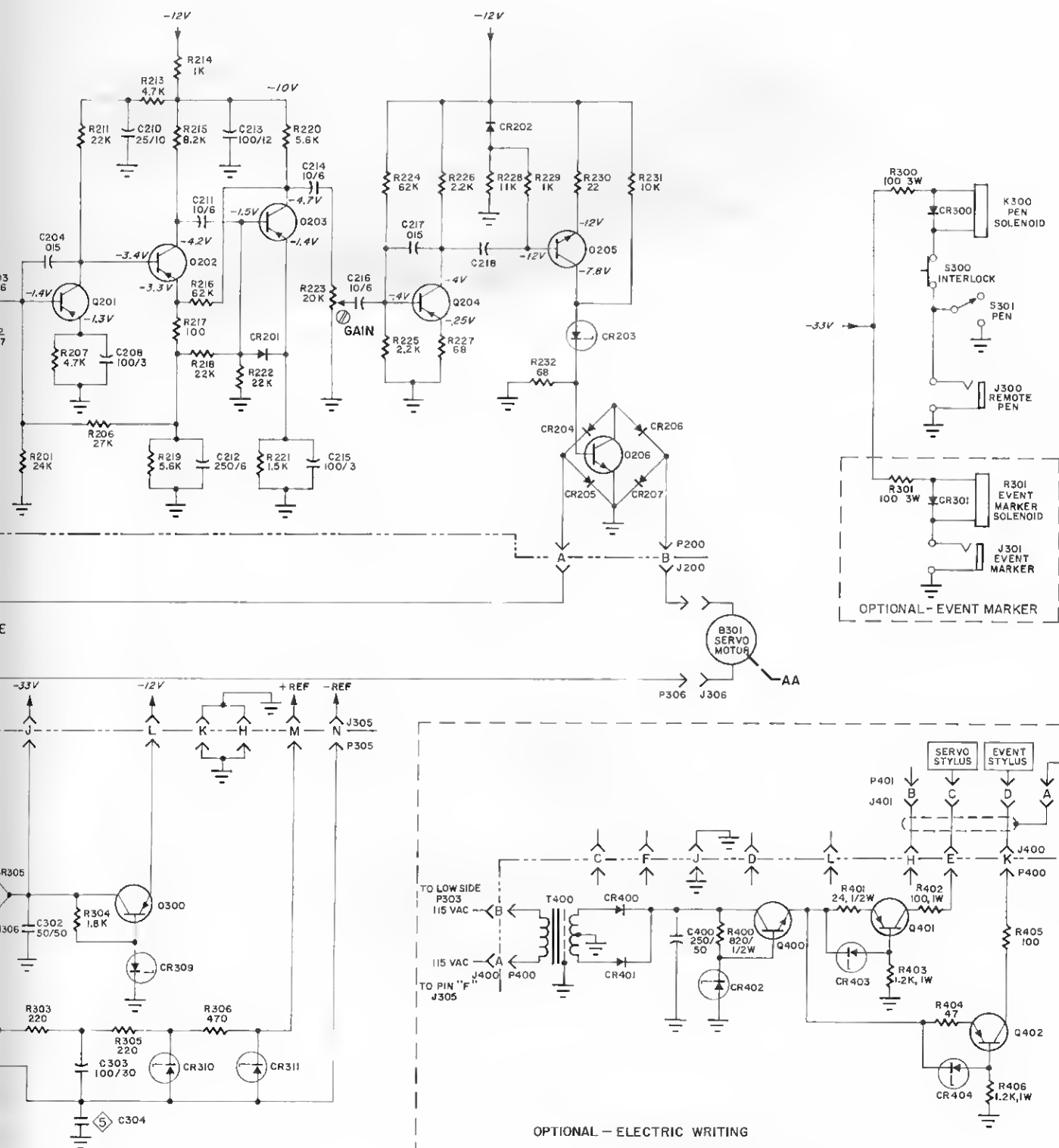
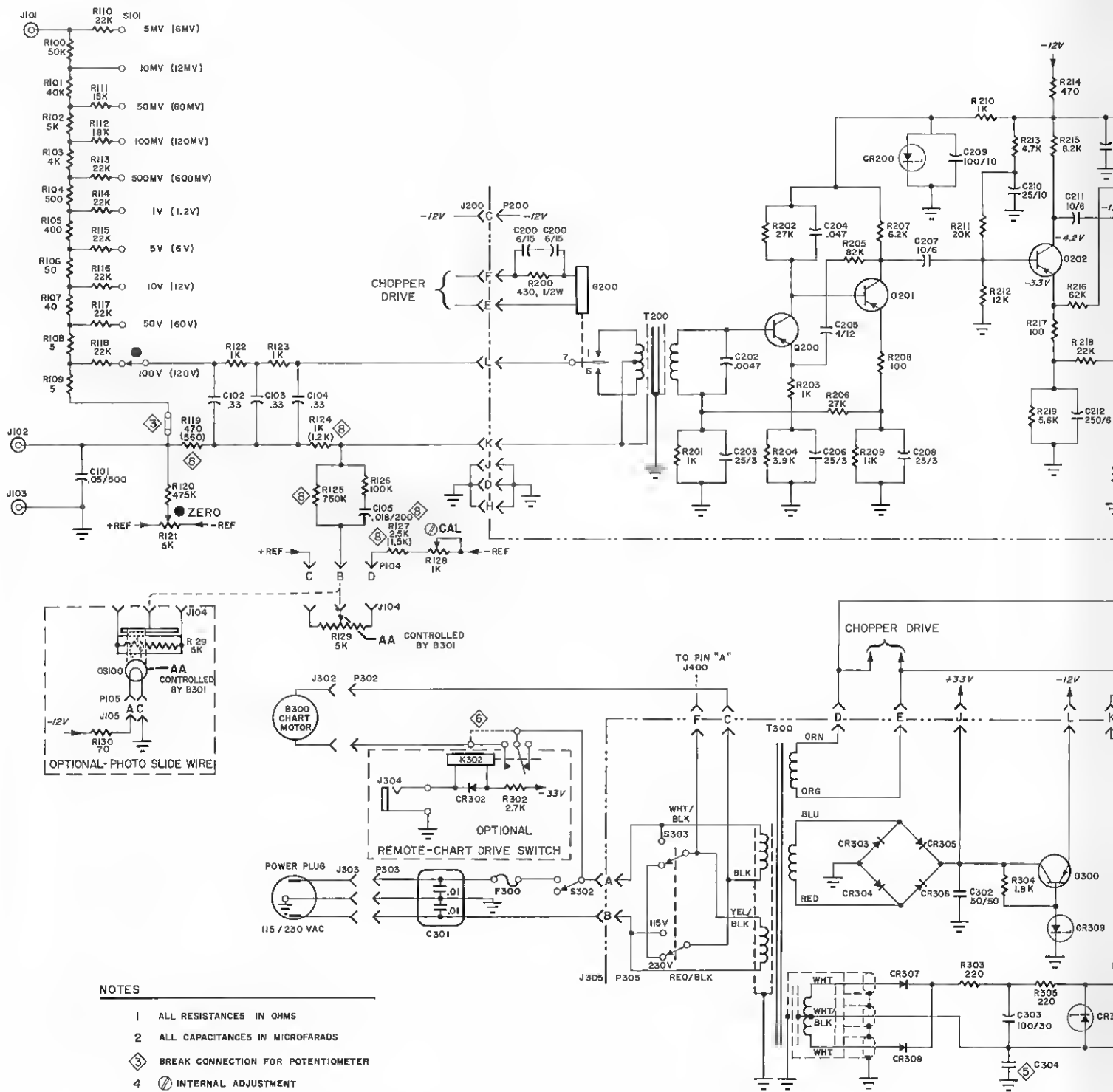


FIGURE 7-18. H01-680/H01-680M  
SCHEMATIC D5950-7316



# NOTES

- 1 ALL RESISTANCES IN OHMS
- 2 ALL CAPACITANCES IN MICROFARADS
- 3 BREAK CONNECTION FOR POTENTIOMETER
- 4 INTERNAL ADJUSTMENT
- 5 PANEL ADJUSTMENT
- 6 FACTORY SELECTED
- 7 BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
- 8 NUMERALS IN PARENTHESES {} APPLY TO METRIC MODEL
- 9 VALUE CHANGES WITH OPTIONS REFER TO PARTS LIST

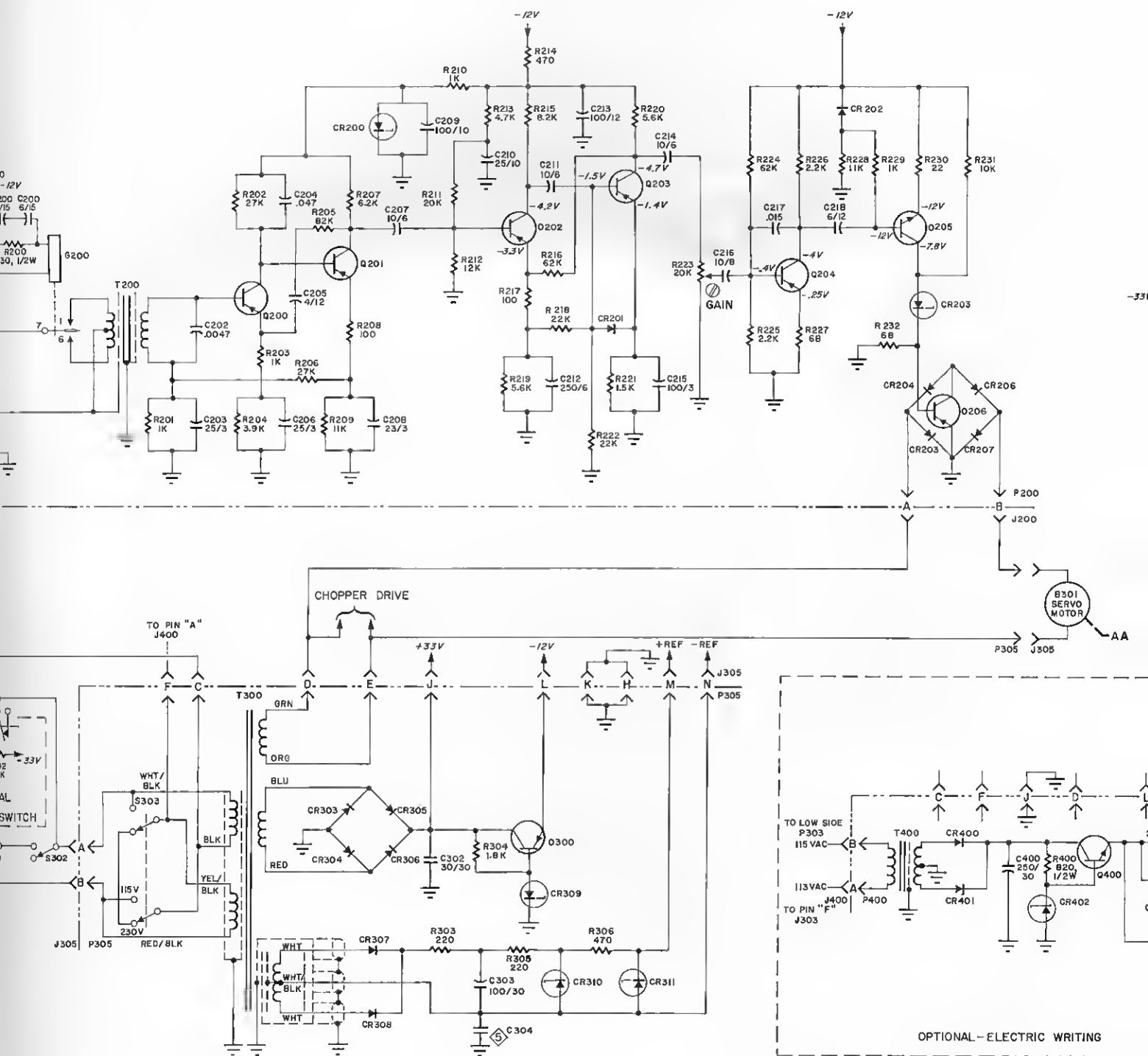


FIGURE 7-19. H



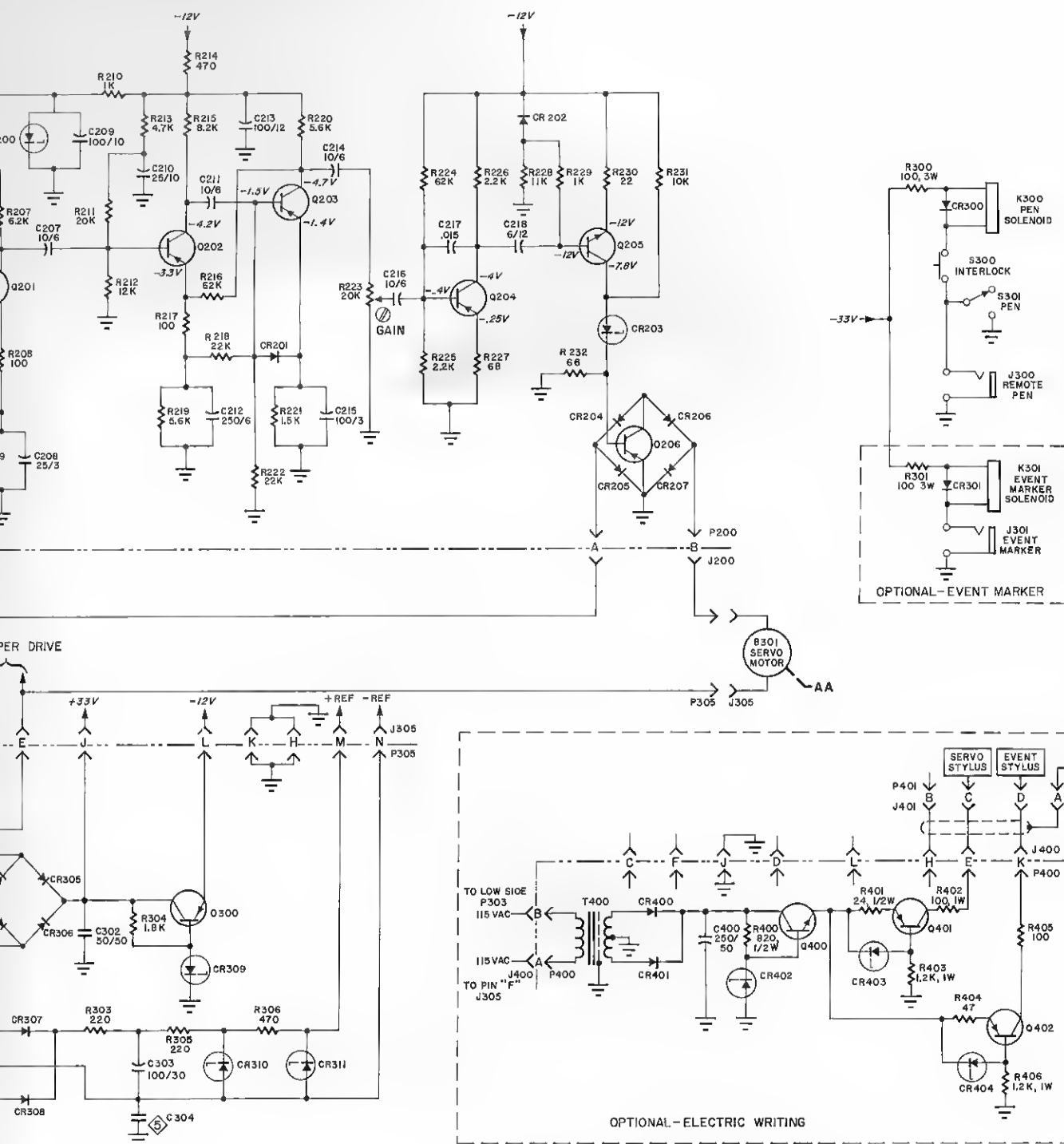
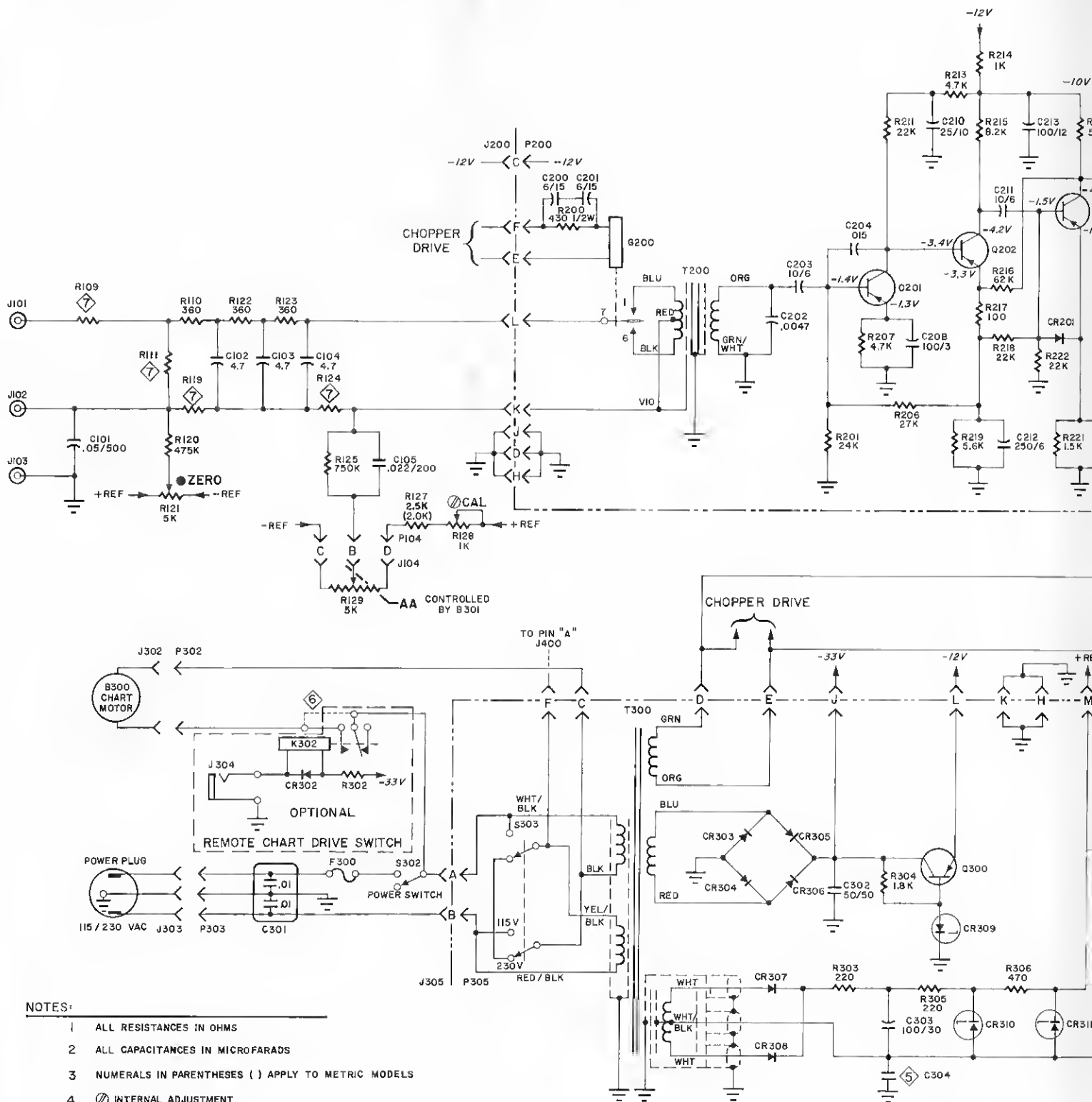







FIGURE 7-19. H02-680/H02-680M SCHEMATIC  
D5950-7315



# NOTES:

- 1 ALL RESISTANCES IN OHMS
- 2 ALL CAPACITANCES IN MICROFARADS
- 3 NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODELS
- 4  INTERNAL ADJUSTMENT  
 PANEL ADJUSTMENT
- 5  FACTORY SELECTED
- 6  BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH OPTION
- 7  FOR VALUES REFER TO FIGURE 6-3

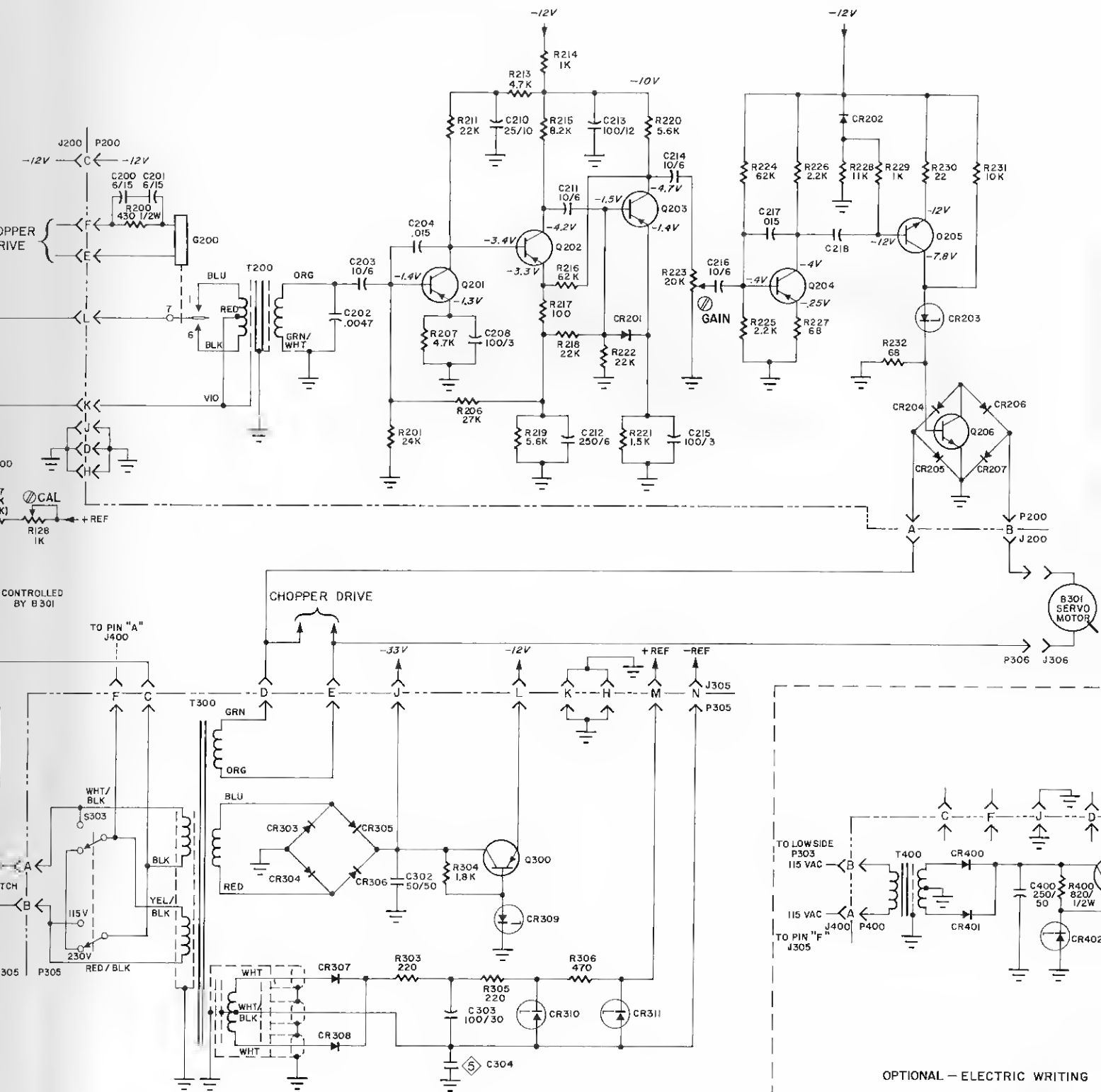


FIGURE 7

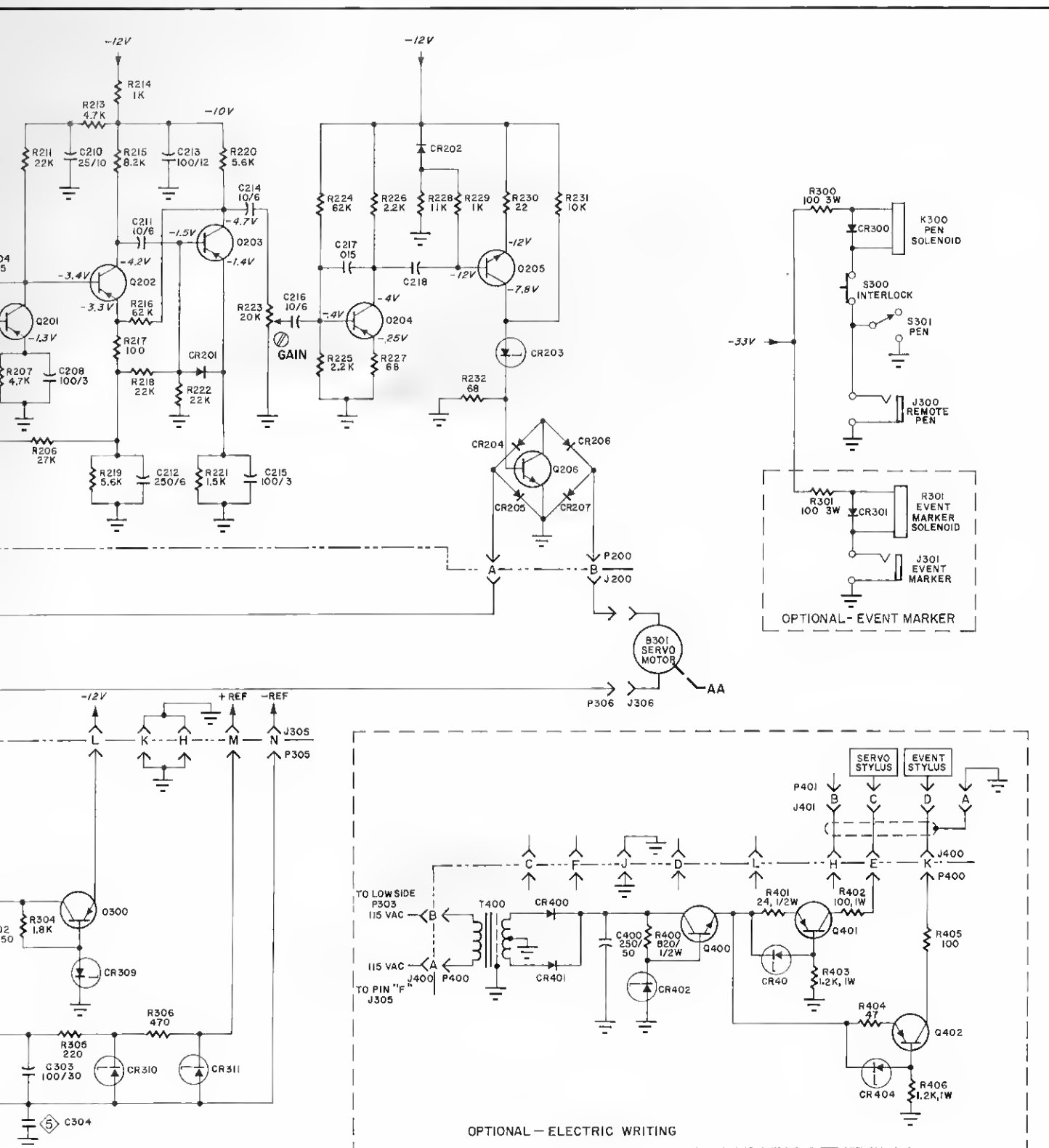
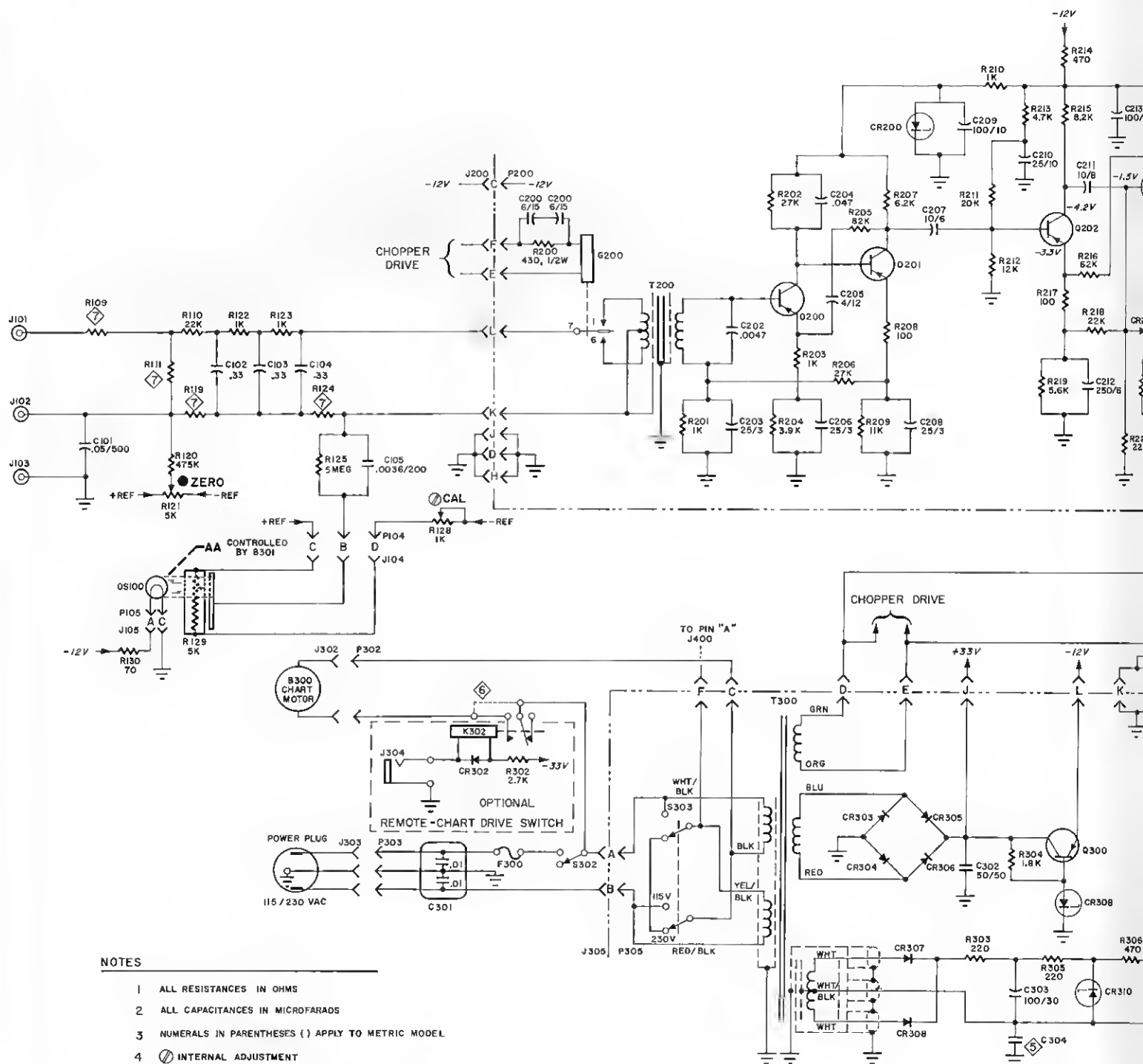





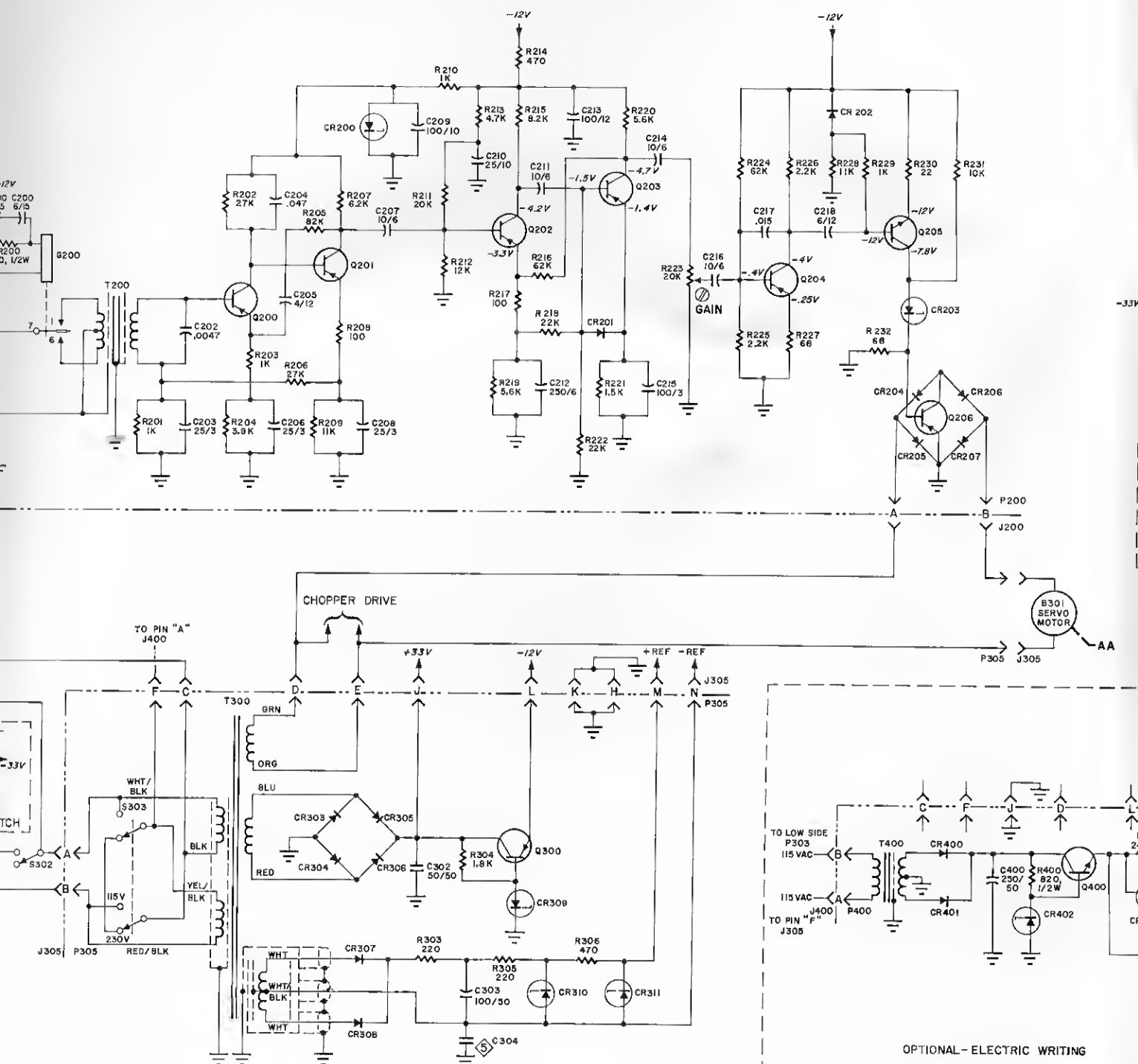


FIGURE 7-20. 681/681M SCHEMATIC D5950-7317



# NOTES

- 1 ALL RESISTANCES IN OHMS
- 2 ALL CAPACITANCES IN MICROFARADS
- 3 NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODEL
- 4  INTERNAL ADJUSTMENT  
 PANEL ADJUSTMENT
- 5  FACTORY SELECTED
- 6  BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
- 7  FOR VALUES REFER TO SEPARATE PARTS LIST



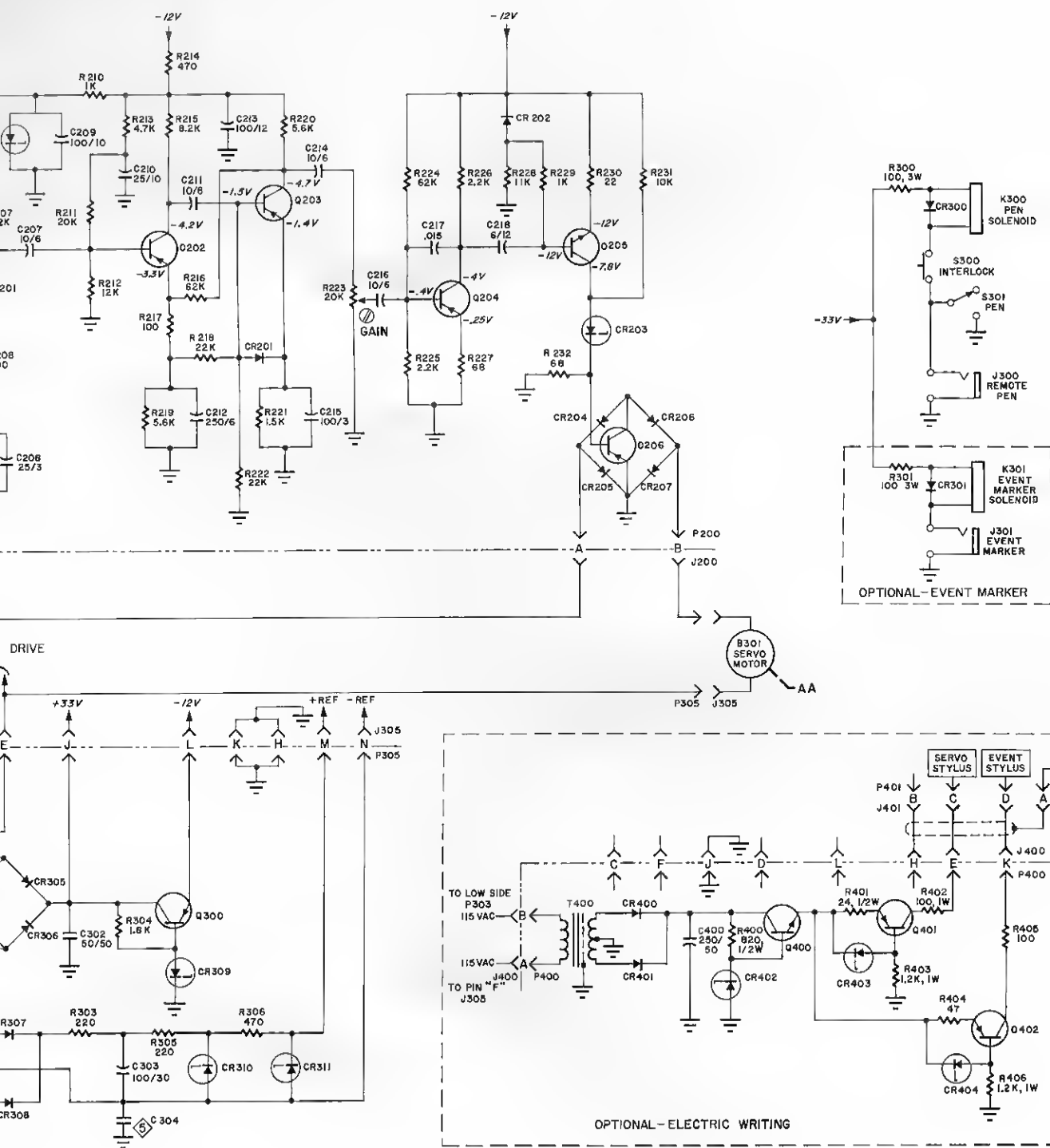
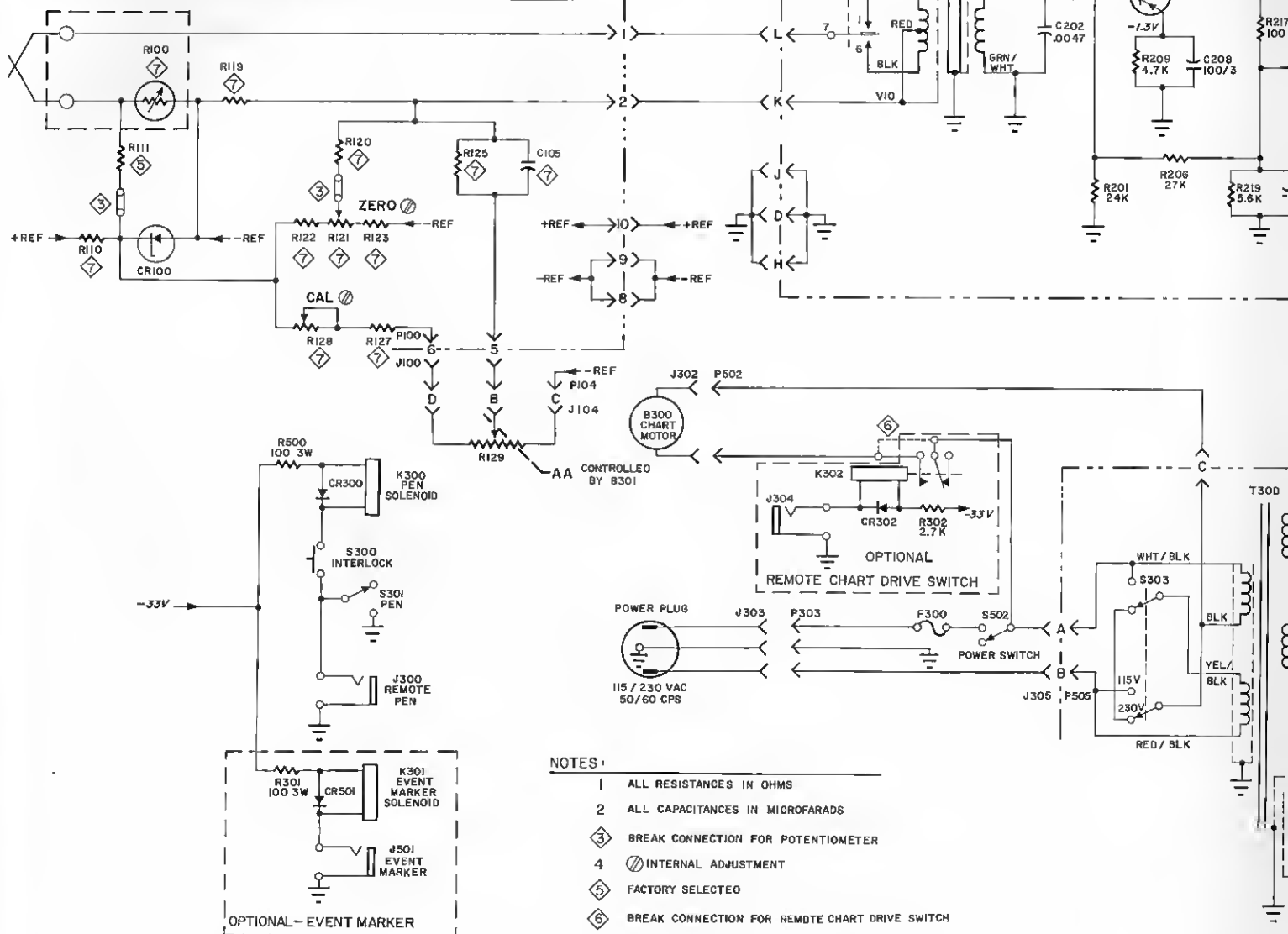


FIGURE 7-21. 681/17/681M-17  
SCHEMATIC D5950-7321

| K MODULE          |          | C105    | R100 | R110  | R119 | R120 | R121  | R122  | R123  | R125  | R127 | R128 |
|-------------------|----------|---------|------|-------|------|------|-------|-------|-------|-------|------|------|
| CHROMEL-ALUMEL    |          |         |      |       |      |      |       |       |       |       |      |      |
| -20°C TO +1200°C  | .025/100 | o       | 470  | 6K    | 1MEG | 1K   | 500   | 3K    | 500K  | 1.5K  | 500  |      |
| 0°C TO +500°C     | .025/100 | o       | 470  | 4.35K | 750K | 1K   | 1K    | 4K    | 750K  | 2.5K  | 1K   |      |
| 0°C TO +1200°C    | .025/100 | o       | 470  | 6K    | 1MEG | 1K   | o     | 3K    | 500K  | 1K    | 1K   |      |
| 0°C TO +1200°C    | .025/100 | o       | 470  | 6K    | 1MEG | 1K   | 3K    | o     | 500K  | 1K    | 1K   |      |
| (METRIC MODEL)    |          | .04/100 | o    | 470   | 6K   | 1MEG | 1K    | 3K    | o     | 500K  | 1K   | 1K   |
| 0°F TO +2500°F    | .025/100 | o       | 470  | 6K    | 1MEG | 1K   | 500   | 2.3K  | 500   | 500   | 500  |      |
| +500°F TO +2500°F | .025/100 | o       | 470  | 6K    | 750K | 1K   | 1.5K  | 2.5K  | 500K  | 2K    | 1K   |      |
| J MODULE          |          |         |      |       |      |      |       |       |       |       |      |      |
| IRON CONSTANTAN   |          |         |      |       |      |      |       |       |       |       |      |      |
| 0°C TO +100°C     | .025/100 | o       | 470  | 1.1K  | 500K | 1K   | 4K    | 1K    | 750K  | 2.5K  | 1K   |      |
| 0°C TO +350°C     | .025/100 | o       | 470  | 5K    | 1MEG | 1K   | 2K    | 4.35K | 750K  | 4.35K | 1K   |      |
| 0°F TO +100°F     | .02/100  | o       | 470  | 560   | 250K | 1K   | 3K    | 500   | 750K  | 2K    | 1K   |      |
| 0°F TO +600°F     | .03/100  | o       | 470  | 3.34K | 750K | 1K   | 1K    | 3K    | 750K  | 2K    | 1K   |      |
| 0°F TO +1200°F    | .03/100  | o       | 470  | 6.94  | 750K | 1K   | 500   | 3.75K | 750K  | 2K    | 1K   |      |
| +30°F TO +150°F   | .02/100  | o       | 470  | 600   | 140K | 1K   | 2.5K  | 2K    | 750K  | 2K    | 1K   |      |
| +600°F TO +1200°F | .025/100 | o       | 470  | 3.34K | 500K | 1000 | 845   | 2K    | 750K  | 1.3K  | 500  |      |
| R MODULE          |          |         |      |       |      |      |       |       |       |       |      |      |
| PLATINUM PT13%RH  |          |         |      |       |      |      |       |       |       |       |      |      |
| +200°C TO +1650°C | .025/100 | o       | 470  | 3.75K | 1MEG | 1K   | o     | 4K    | 750K  | 2.5K  | 500  |      |
| T MODULE          |          |         |      |       |      |      |       |       |       |       |      |      |
| COPPER CONSTANTAN |          |         |      |       |      |      |       |       |       |       |      |      |
| -200°C TO +50°C   | .025/100 | o       | 100K | 470   | 1K   | 750K | 1K    | o     | 2.5K  | 600K  | 500  | 1K   |
| -100°C TO +50°C   | .03/100  | o       | 470  | 1K    | 750K | 1K   | 3.34K | 2.5K  | 750K  | 2K    | 1K   |      |
| -100°C TO +150°C  | .025/100 | o       | 100  | 470   | 2K   | 750K | 1K    | 1K    | 4.35K | 750K  | 2K   | 1K   |
| -150°F TO +300°F  | .02/100  | o       | 1K   | 2.5K  | 750K | 500  | 1K    | 2.6K  | 750K  | 2K    | 500  |      |
| +150°F TO +300°F  | .025/100 | o       | 470  | 1.5K  | 750K | 1K   | 5K    | 2.5K  | 750K  | 4K    | 500  |      |





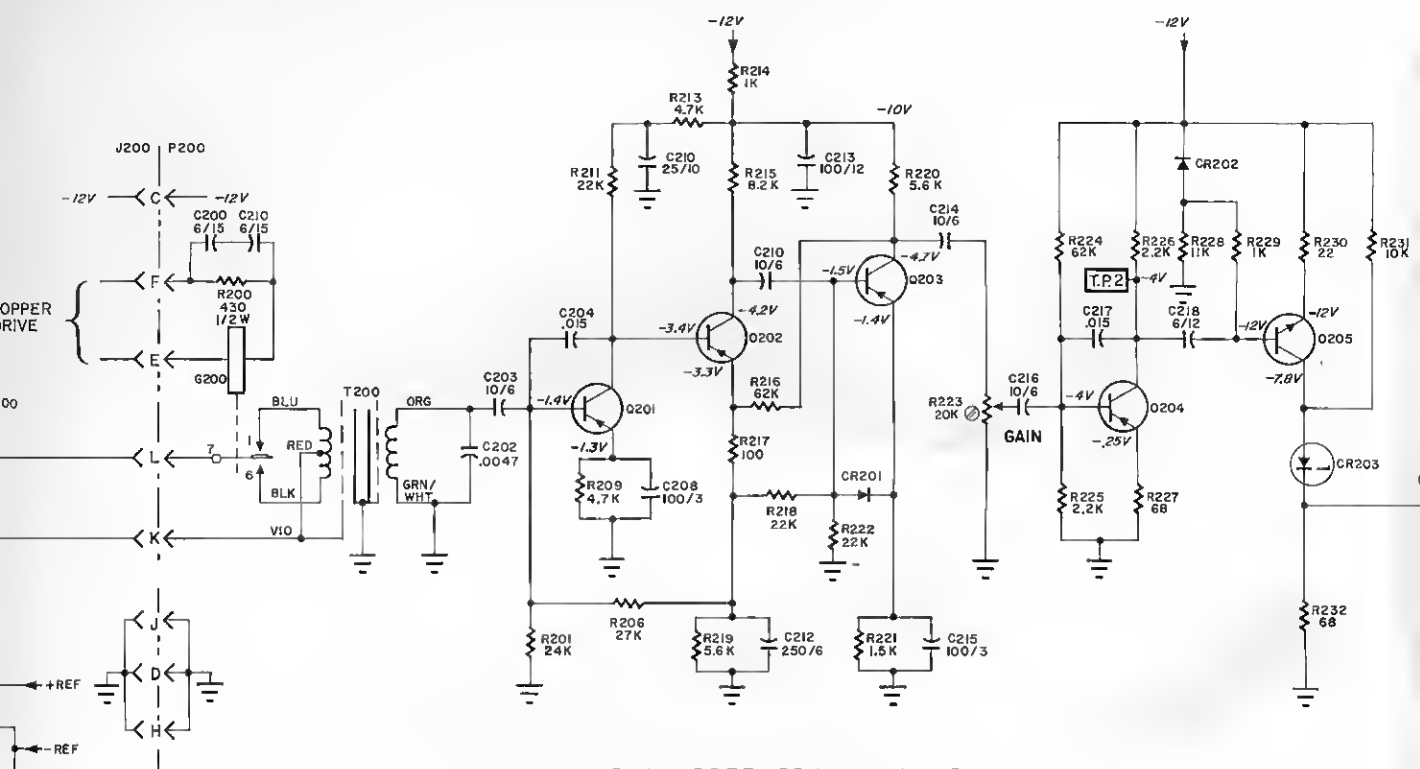


FIGURE 7-22

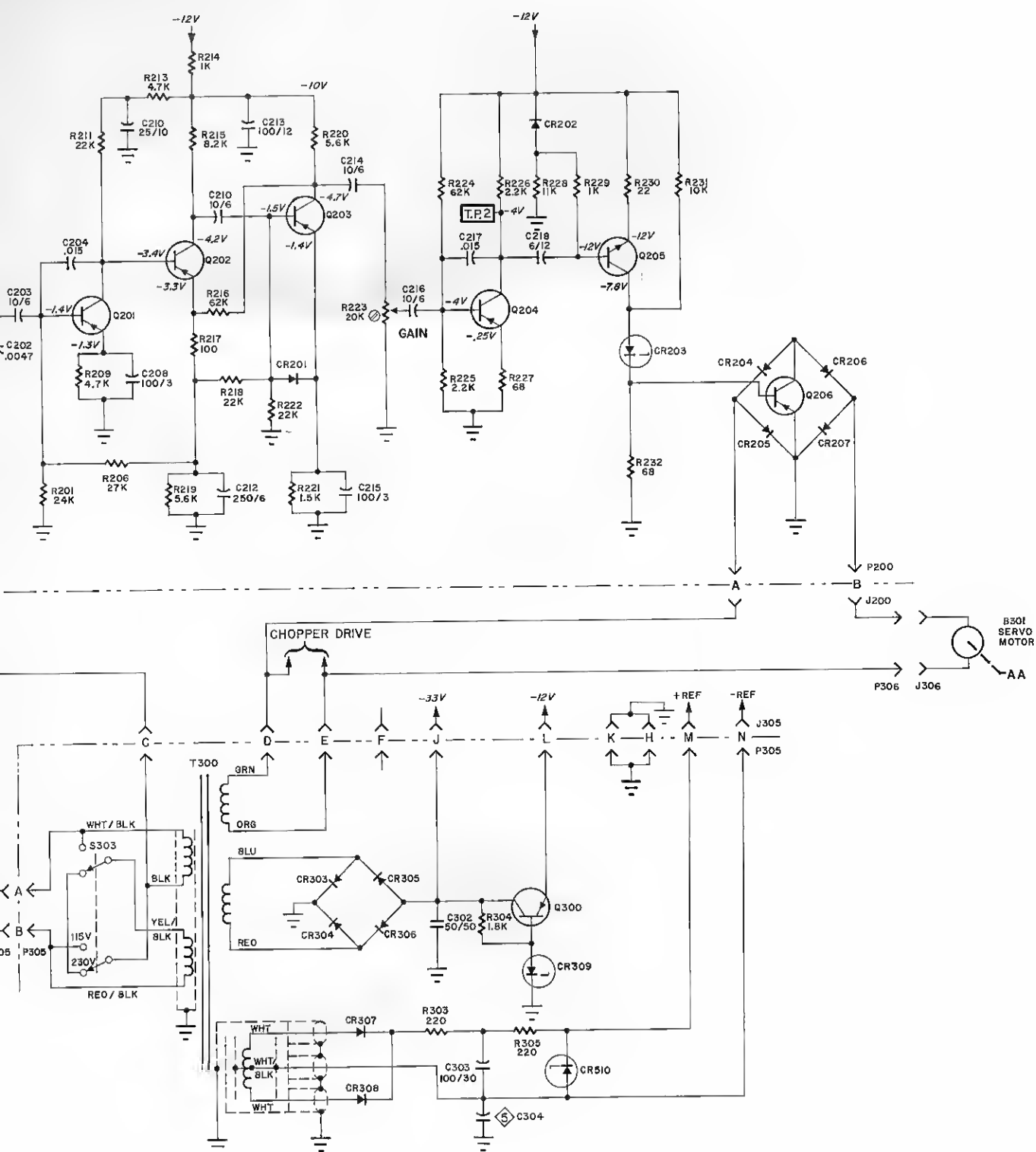
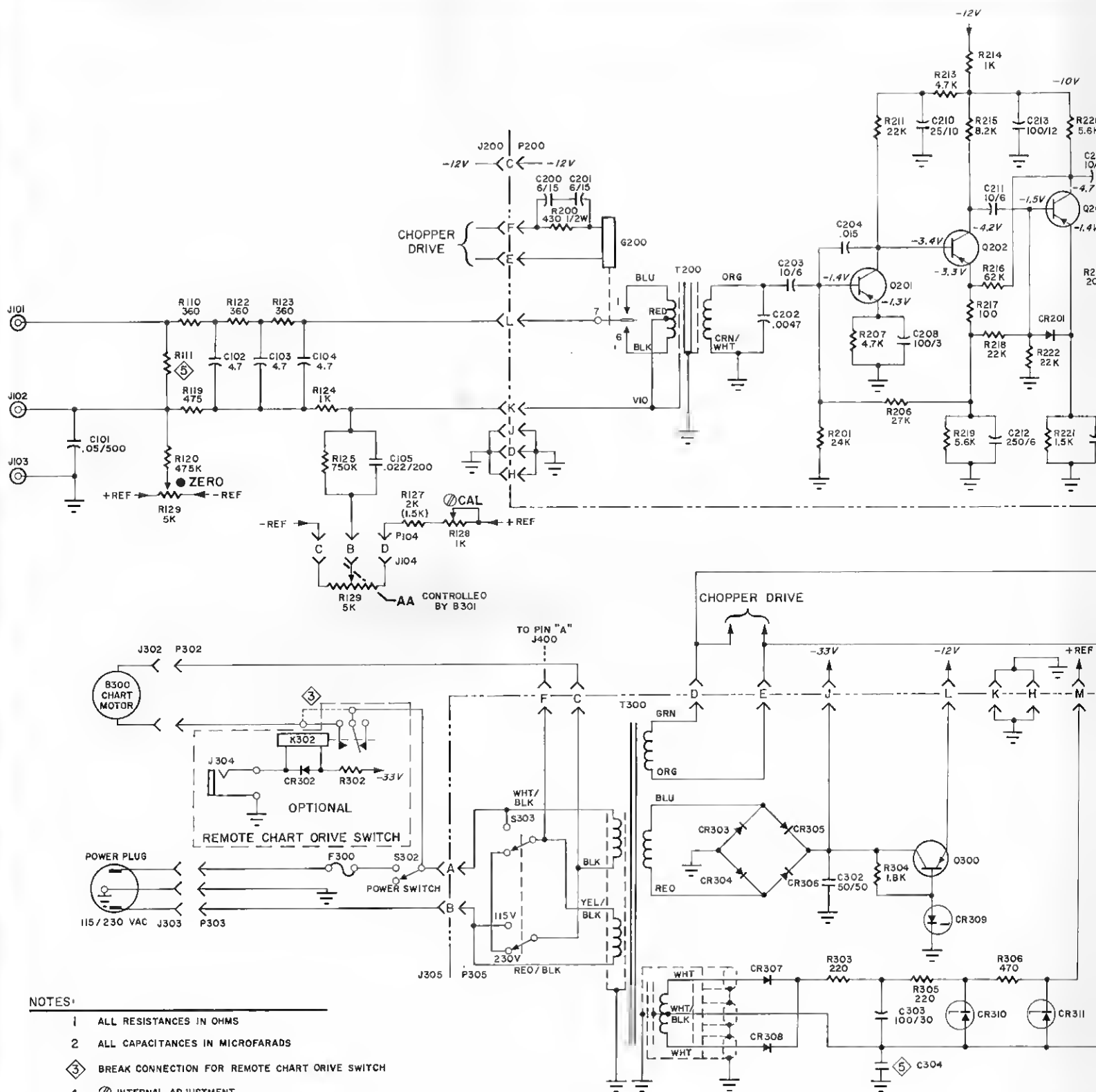


FIGURE 7-22. 682/682M SCHEMATIC D5950-7318



- NOTES:
- 1 ALL RESISTANCES IN OHMS
  - 2 ALL CAPACITANCES IN MICROFARADS
  - 3 BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
  - 4 INTERNAL ADJUSTMENT
  - 5 PANEL ADJUSTMENT
  - 6 FACTORY SELECTED

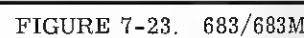


FIGURE 7-23. 683/683M

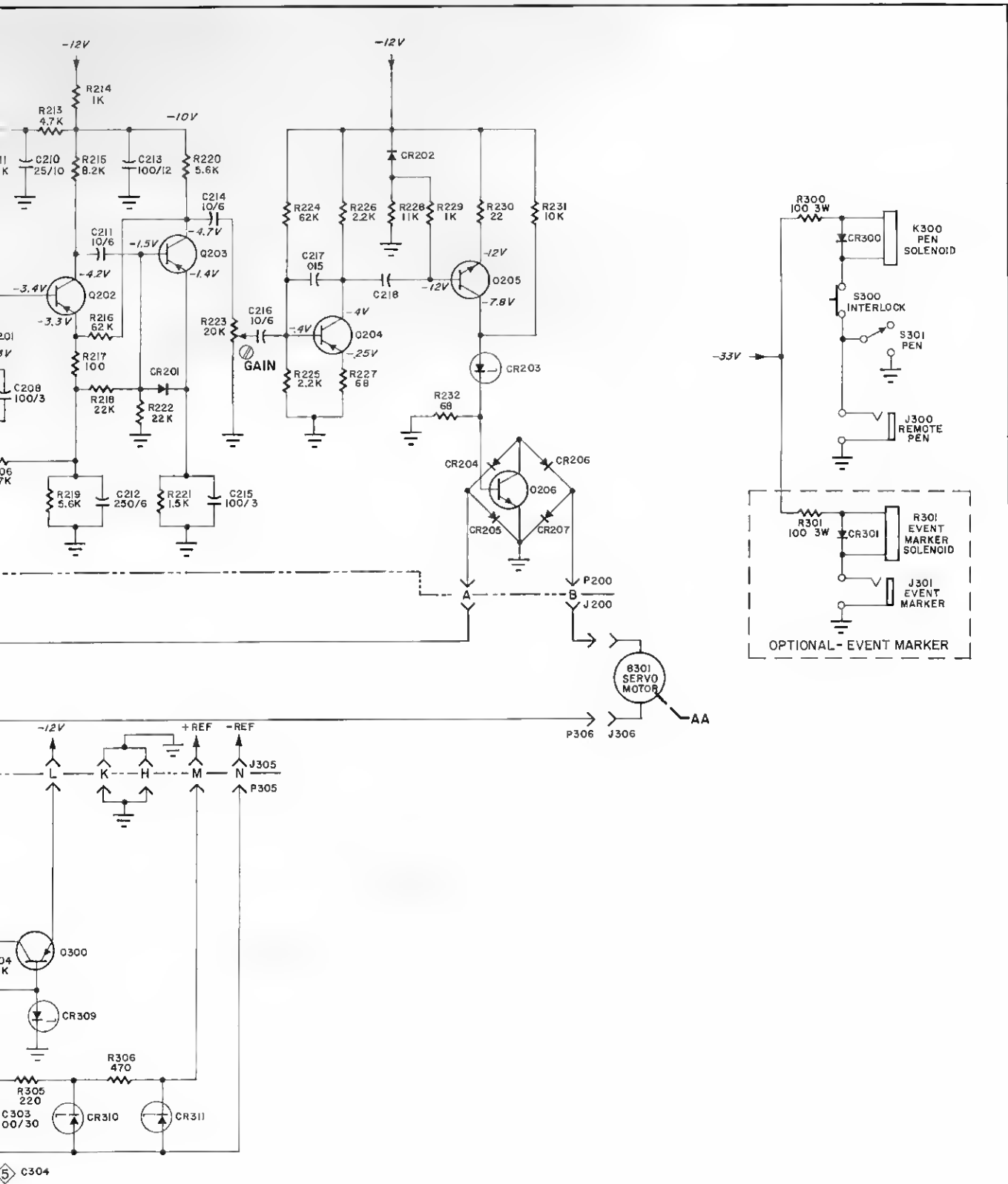


FIGURE 7-23. 683/683M SCHEMATIC D5950-7319